ENVIRONMENTAL PROTECTION AGENCY
40 CFR Part 94
[AMS-FRL-6196-3]

RIN 2060-AI17

Control of Emissions of Air Pollution from New CI Marine Engines at or above 37 kW

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of Proposed Rulemaking.

SUMMARY: In this action, EPA is proposing an emission control program for new compression-ignition marine engines rated at or above 37 kilowatts. The affected engines are used for propulsion and auxiliary purposes in a wide variety of marine applications. The standards proposed for these engines would require substantial reductions in oxides of nitrogen and particulate matter emissions to correspond with the next round of emission standards for comparable land-based engines. The proposed standards are expected to provide a significant reduction in oxides of nitrogen and particulate matter emissions from this source. When combined with other mobile source emission control programs, the program described in this action will help provide long-term improvements in air quality in many port cities and other coastal areas. Overall, the proposed program would provide much-needed assistance to states facing ozone and particulate air quality problems, which can cause a range of adverse health effects for their citizens, especially in terms of respiratory impairment and related illnesses.

The persons potentially affected by this action are those who manufacture new compression-ignition marine engines or marine vessels or other equipment using such engines. Additional requirements apply to companies that rebuild or maintain these engines.

DATES: EPA will hold a hearing on the proposed rulemaking on January 19, 1999. EPA requests comments on the proposed rulemaking by February 26, 1999. More information about commenting on this action and on the public hearing and meeting may be found under Public Participation in "SUPPLEMENTARY INFORMATION," below.

ADDRESSES: Materials relevant to this proposal, including the Draft Regulatory Impact Analysis, are contained in Public Docket A-97-50. Additional materials relevant to EPA's earlier proposal, which was published in 1994 and supplemented in 1996 but not finalized, can be found in Public Docket A-92-28 (Control of Air Pollution; Emission Standards for New Gasoline Spark-Ignition and Diesel Compression- Ignition Marine Engines). Both of these dockets are located at room M-1500, Waterside Mall (ground floor), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460. The docket may be inspected from 8:00 a.m. until 5:30 p.m., Monday through

Friday. A reasonable fee may be charged by EPA for copying docket materials.

Comments on this proposal should be sent to Public Docket A-97-50 at the above address. EPA requests that a copy of comments also be sent to Jean Marie Revelt, U.S. EPA, Engine Programs and Compliance Division, 2000 Traverwood Dr., Ann Arbor, MI 48105.

The public hearing will be held at the National Vehicle and Fuel Emissions Laboratory, 2000 Traverwood Drive, Ann Arbor, Michigan. The public hearing will begin at 10 a.m. and will continue until all testimony has been presented. People who wish to testify will be requested to register on the day of the hearing. Time limits may be imposed for each speaker, depending on the number of people who request to testify. A transcript of the hearing will be placed in the docket. Arrangements for copies may also be made directly with the court reporter, on the day of the hearing. The court reporter may charge a fee for this service.

For further information on electronic availability of this proposal, see "SUPPLEMENTARY INFORMATION" below.

FOR FURTHER INFORMATION CONTACT: Margaret Borushko, U.S. EPA, Engine Programs and Compliance Division, (734) 214-4334; Borushko.Margaret@epa.gov.

SUPPLEMENTARY INFORMATION:

Regulated entities

Persons or companies potentially regulated by this action are those that manufacture or introduce into commerce new compression-ignition marine engines and those that make vessels or other equipment using such engines. Further requirements apply to companies that rebuild or maintain marine engines. Regulated categories and entities include:

Category	Examples of regulated entities	NAICS Code	SIC Code
Industry	Manufacturers of new marine diesel engines	333618	3519
Industry	Manufacturers of marine vessels	3366	3731 3732
Industry	Engine repair and maintenance	811310	7699

This list is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. To determine whether particular activities may be regulated by this action, the reader should carefully examine the proposed regulations, especially the applicability criteria in §94.1. Questions regarding the applicability of this action to a particular entity may be directed to the person listed in "FOR FURTHER INFORMATION CONTACT."

Obtaining Electronic Copies of the Regulatory Documents

The preamble, regulatory language and Draft Regulatory Impact Analysis are also available electronically from the EPA Internet Web site. This service is free of charge, except for any cost already incurred for internet connectivity. The electronic version of this proposed rule is made available on the day of publication on the primary Web site listed below. The EPA Office of Mobile Sources also publishes Federal Register notices and related documents on the secondary Web site listed below.

1. http://www.epa.gov/docs/fedrgstr/EPA-AIR/
   (either select desired date or use Search feature)
2. http://www.epa.gov/OMSWWW/
   (look in What's New or under the specific rulemaking topic)

Please note that due to differences between the software used to develop the document and the software into which the document may be downloaded, changes in format, page length, etc., may occur.

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I. Introduction

Air pollution is a serious threat to the health and well-being of millions of Americans, and imposes a large burden on the U.S. economy. As discussed below, ground-level ozone and PM have been linked to potentially serious respiratory health problems and environmental degradation. Over the past two decades, emission control programs established at the state and federal levels have significantly reduced emissions from individual sources, and many of these sources now pollute at only a fraction of their precontrol rates. These programs have concentrated on reducing ground-level ozone levels, with a focus on its main precursors, oxides of nitrogen (NOx) and volatile organic compounds (VOCs).[1] In addition, steps have been taken to reduce airborne particulate matter (PM), which is also a major air quality concern in many regions.

However, continued industrial growth and expansion of motor vehicle usage threaten to reverse these past achievements. Today, many states are finding it increasingly difficult to meet the current ozone and particulate matter National Ambient Air Quality Standards (NAAQS) by the deadlines established in the Clean Air Act (the "Act").[2] In addition, even those states that are approaching or have reached attainment of the current ozone and PM NAAQS are likely to see these gains lost if current trends persist.

National mobile source emission control programs have been successful in reducing NOx, HC, and PM emissions from new regulated engines. These programs have resulted in reductions of more than 90 percent on a per-vehicle basis for new gasoline-fueled passenger cars. Emissions from light-duty trucks have also been reduced to very low levels. The more recent diesel engine programs, as supplemented by new, more stringent requirements for highway and nonroad diesel engines, will significantly reduce emissions from that category as well. As a result of these programs, emission reductions on a per-vehicle or per-engine basis have greatly offset emission increases due to the rising mobile source population and usage rates.

Until now, EPA's effort to control emissions from marine sources has been limited to outboard and personal watercraft engines and marine diesel engines rated under 37 kW. EPA's analysis of national NOx and PM levels suggests that marine diesel engines are a considerable source of these pollutants. The inventory contribution of marine diesel engines is presented under Background (Section II.A.4.), and is described in greater detail in the Draft Regulatory Impact Analysis. Consequently, emission controls for these engines may yield important reductions in national NOx and PM inventories. At the same time, designing an emission control program for marine diesel engines at or above 37 kW poses certain challenges. The tremendous range of engine sizes in this category, from small generators used onboard fishing or recreational vessels to large propulsion engines used onboard ocean-going vessels, suggests a need to set different requirements for different groups of engines. In addition, technological challenges inherent to nonroad diesel-cycle engine design must be addressed.[3] Traditional NOx control approaches tend

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[1]VOCs consist mostly of hydrocarbons (HC), including nonmethane hydrocarbons (NMHC).

[2]See 42 U.S.C. 7401, et seq.

[3]References to diesel-cycle engines, also referred to as "diesel engines" in this document, are intended to cover a particular kind of engine technology, i.e., compression ignition combustion. Compression-ignition engines are typically operated on diesel fuel, although other fuels, such as compressed natural gas, may also be used. This contrasts with otto-cycle engines (also called spark-ignition or SI engines), which typically operate on gasoline. The requirements set out in this notice are intended to apply to all

to increase PM emissions, and vice versa. However, methods to achieve simultaneous NOx and PM control are being developed for land-based diesel engines, and EPA believes similar solutions can be applied to marine diesel engines due to similarities among the engines. A more complete discussion of technology issues is presented under Technological Feasibility (Section VII). Finally, the large number of ship and boat builders and their relative inexperience with emission control requirements suggest a need for a flexible implementation process. A more detailed discussion of the characteristics of this industry is included under Industry Characterization (Section II.C.).

In this document, EPA is proposing to extend the federal emission control program to the marine segment of the nonroad industry by proposing an emission control program for all new marine diesel engines rated over 37 kW.[4] The program described in this action follows EPA's Supplemental Advance Notice of Proposed Rulemaking (Supplemental ANPRM), published on May 22, 1998 (63 FR 28309), and the comments received on that notice and other new information provide the framework for its provisions.

II. Background

A. Air Quality Problems Addressed in the Proposed Rule

The emission standards proposed in this document will provide important reductions of ground-level ozone and particulate matter (PM) nationally, as well as carbon monoxide (CO) control. This section summarizes the air quality rationale for these new emission standards and their anticipated impact on marine diesel engines.

1. Ozone

Ground-level ozone is formed by complex photochemical reactions involving HC and NOx in the presence of sunlight.[5] According to a growing body of research, ground-level ozone can have harmful physical effects on humans. It severely irritates the mucous membranes of the nose and throat, which can lead to coughing and even choking. It also impairs normal functioning of the lungs, and chronic exposure may cause permanent lung damage. The risk of suffering these effects are particularly high for children and for people with compromised respiratory systems. Ground-level ozone has also been shown to injure plants and building materials.

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combustion-ignition engines.

[4]This proposal is based on metric units. To convert to English units, one kilowatt equals 1.341 horsepower.

[5]Ground-level ozone should not be confused with stratospheric ozone, a protective layer of the upper atmosphere that filters the sun's harmful ultraviolet rays.

Diesel engines contribute to ground-level ozone levels primarily through their NOx emissions, which are a much higher portion of total NOx+HC emissions than for most gasoline engines. This is of significant concern not only because of ozone impacts but also because NOx has important independent effects on human health and general environmental conditions. NOx includes several gaseous compounds that are lung irritants and can increase susceptibility to respiratory illness and pulmonary infection. NOx also contributes to the secondary formation of PM (nitrates), acid deposition, and the overgrowth of algae in coastal estuaries. Additional information on these environmental and health effects may be found in EPA staff papers and air quality criteria documents for ozone and nitrogen oxides.[6,7,8,9]

Acceptable levels of ground-level ozone have been set by EPA pursuant to the Act. States are divided into areas for air quality planning purposes, and these areas are categorized as to whether they meet the current National Ambient Air Quality Standard for ozone by the deadlines established in the Act.[10] As of October, 1997 there are 59 areas designated as in “nonattainment” for ozone.

The state and local governmental organizations charged with designing and implementing emission control programs to bring these areas into attainment have mounted significant efforts in recent years to reduce ozone concentrations. Their state implementation plans, combined with federal mobile source emission control programs, have yielded encouraging signs of success. The main precursors of ozone, NOx and VOCs (including HC), have been reduced in many areas, and average ozone levels are beginning to decrease. However, this progress is in jeopardy. EPA projects that emission increases that accompany economic expansion will eventually outpace per-source reductions in ozone precursors. Increases in the number of sources, as well as increased use of existing sources, mean that even full implementation of current emission control programs will fall short of what will be needed to achieve and maintain ozone attainment. By the middle of the next decade, the Agency expects that, without additional controls,

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[6] U.S. EPA, “Review of National Ambient Air Quality Standards for Ozone, Assessment of Scientific and Technical Information,” OAQPS Staff Paper, EPA-452/R-96-007, 1996 (Air docket A-95-58).

[7] U.S. EPA, “Air Quality Criteria for Ozone and Related Photochemical Oxidants,” EPA/600/P-93/004aF, 1996 (Air Docket A-95-58).

[8] U.S. EPA, “Review of National Ambient Air Quality Standards for Nitrogen Dioxide, Assessment of Scientific and Technical Information,” OAQPS Staff Paper,” EPA-452/R-95-005, 1995 (Air Docket A-93-06).

[9] U.S. EPA, “Air Quality Criteria for Oxides of Nitrogen,” EPA/600/8-91/049aF, 1993 (Air Docket A-93-06).

[10] See 42 U.S.C. 7401, *et seq*.

the downward trends in overall ground-level ozone will be reversed. Consequently, it is important to develop new strategies that improve, or at least maintain, the progress in ozone reductions that have been achieved to date.

2. Particulate Matter

Particulate matter, like ozone, has been linked to a range of serious respiratory health problems. Particulate matter is a collection of small particles emitted by diesel engines. Many different organic pollutants are adsorbed on these particles. The size and chemical composition of particulate matter are the main reasons for concern about the effects of PM on human health. Their small size increases the likelihood that the particles will reach and lodge in the deepest and most sensitive areas of human lungs. This can lead to severe lung problems and increases susceptibility to respiratory infection, such as pneumonia, aggravation of acute and chronic bronchitis, and asthma. It can also lead to decreased lung function (particularly in children and individuals with asthma) and alterations in lung tissue and structure and in respiratory tract defense mechanisms. Additional information on these effects may be found in an EPA staff paper and an air quality criteria document for particulate matter.[11,12]

Acceptable levels of PM have also been set by EPA. Currently, there are 80 PM-10 nonattainment areas across the U.S. (PM-10 refers to particles smaller than 10 microns in diameter.) As is the case with NOx, levels of PM caused by stationary and mobile sources are expected to rise in the future, not only because of the increase in number of sources and activity levels of these sources, but also because elevated NOx levels can lead to increased PM levels. This is because NOx from diesel engines and other sources is transformed in the atmosphere into fine secondary nitrate particles. Secondary nitrate PM, consisting mostly of ammonium nitrate, accounts for a substantial fraction of the airborne particulate in some areas of the country. EPA believes that mobile sources contribute substantially to the fraction of ambient PM that is generally considered controllable.[13] Consequently, EPA has been developing new mobile source strategies to control PM emissions.

3. Carbon Monoxide

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[11] U.S. EPA, "Review of National Ambient Air Quality Standards for Particulate Matter, Assessment of Scientific and Technical Information," OAQPS Staff Paper, EPA-452/R-96-013, 196 (Air Docket A-95-54).

[12] U.S. EPA, "Air Quality Criteria for Particulate Matter," EPA/60/P-95/001aF, 1996 (Air Docket A-95-54).

[13] The largest fraction of ambient PM is attributed to "miscellaneous" and "natural" sources, including wind erosion, wildfires, and fugitive dust, which are difficult or impossible to control.

Along with NOx, HC, and PM, carbon monoxide (CO) is another mobile source pollutant that is addressed by the program proposed in this document. CO has long been known to have substantial adverse effects on human health and welfare, including toxic effects on blood and tissues, and effects on organ functions. CO has been linked to fetal brain damage, reduced visual perception, cognitive functions and aerobic capacity, and increased risk of heart problems for people with heart disease. There are currently approximately 20 serious or moderate CO nonattainment areas in the United States.

4. Contribution of Marine Diesel Engines to NOx, HC, PM and CO Levels

EPA's inventory analysis suggests that marine diesel engines are a significant source of NOx and PM emissions. This inventory analysis, presented in more detail in the Draft Regulatory Impact Analysis prepared for this action, suggests that marine diesel engines currently contribute approximately one million tons of NOx per year, representing 8.1 percent of mobile source NOx and 4.8 percent of total NOx emissions. Marine diesel engines also contribute approximately 42,000 tons of PM per year, representing 4.4 percent of the directly emitted PM from mobile sources and 1.0 percent of total directly emitted PM emissions.[14] In addition to directly emitted PM, EPA estimates that, as a national average, marine diesel engines contribute approximately 40,000 tons of PM in the form of secondary nitrate particles, based on the estimated one million tons of NOx emitted by these engines. In addition, emissions from marine diesel engines tend to be concentrated in specific areas of the country (ports, coastal areas, and rivers), and so local levels of these pollutants can be much higher. Consequently an emission control program that addresses NOx and PM emissions from marine diesel engines can be an important tool toward the goal of reducing the health and environmental hazards associated with these and other pollutants.

The contribution of marine diesel engines to national HC and CO levels is much less than for NOx and PM. EPA estimates that marine diesel engines contribute less than two-tenths of one percent of the national levels of these pollutants. Nevertheless, the program being proposed in this rule includes limits for HC and CO emissions. These limits will provide a small, positive, air quality benefit.

B. Legislative and Regulatory History

1. Statutory Authority

Section 213(a)(1) of the Clean Air Act directed the Agency to study emissions from nonroad engines and vehicles to determine, among other things, whether these emissions "cause, or significantly contribute to, air pollution that may reasonably be anticipated to endanger public health or welfare." Section 213(a)(2) further required EPA to determine whether the emissions of CO, VOC, and NOx found in the above study significantly

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[14]Excluding erosion or fugitive dust.

contribute to ozone or CO emissions in more than one nonattainment area. With an affirmative determination of significance, section 213(a)(3) requires the Agency to establish emission standards regulating CO, VOC, and NOx emissions from new nonroad engines and vehicles. EPA may also promulgate emission standards under section 213(a)(4) regulating any other emissions from nonroad engines that EPA finds contribute significantly to air pollution.

The Nonroad Engine and Vehicle Emission Study required by section 213(a)(1) was completed in November 1991.[15] On June 17, 1994, EPA made an affirmative determination under section 213(a)(2) that nonroad emissions are significant contributors to ozone or CO in more than one nonattainment area.[16] In the same document, EPA set a first phase of emission standards ("Tier 1 standards") for land-based nonroad diesel engines rated at or above 37 kW.[17] These requirements were recently augmented by a new rulemaking that sets more stringent Tier 2 emission levels for new land-based nonroad diesel engines at or above 37 kW as well as Tier 1 standards for nonroad diesel engines less than 37 kW.[18] EPA has also initiated additional rulemakings to set emission standards for other subgroups of nonroad engines, including spark-ignition (SI, typically gasoline) engines less than 19 kW,[19] spark-ignition (SI, typically gasoline) marine engines (outboards and personal watercraft),[20] and locomotives.[21] This action takes another step toward the comprehensive nonroad engine emission control strategy envisioned in the Act by proposing an emission control program for marine diesel engines at or above 37 kW.

2. Regulatory History

Numerical emission standards for marine diesel engines were originally proposed in 1994, as part of a proposed rule for control of emissions from both spark-ignition and

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[15]This study is available in docket A-92-28.

[16]See 59 FR 31306, June 17, 1994.

[17]Ibid.

[18]See 63 FR 56967, October 23, 1998.

[19]See 60 FR 34582 (July 3, 1995) for the final rule establishing Tier 1 standards and 62 FR 14740 (March 27, 1997) for the ANPRM discussing Tier 2 standards.

[20]See 61 FR 52087 (October 4, 1996) for the final rule. EPA did not set numerical emission standards for sterndrive and inboard gasoline marine engines in this rule.

[21]See 62 FR 6365 (February 11, 1997); the final rule was signed December 17, 1997 and is available electronically (see Section VI below).

compression-ignition marine engines.[22] At that time, EPA had a limited understanding of the marine diesel industry and, relying on the similarities between land-based nonroad and marine diesel engines, proposed to apply the same emission levels as those in the then just-finalized land-based nonroad rule. The nonroad Tier 1 standards are set out in Table 1. EPA proposed that these standards for marine diesel engines take effect January 1, 1999 for engines less than 560 kW, and January 1, 2000, for engines 560 KW and above. Although no upper limit on engine size was proposed for application of these standards to marine diesel engines, EPA requested comment on whether an upper limit should be established above which the emission control program being developed concurrently under the auspices of the International Maritime Organization (IMO) should apply. The IMO is the Secretariat for the International Convention on the Prevention of Pollution from Ships (that convention is also referred to as MARPOL 73/78). Annex VI to that Convention, adopted on September 27, 1997 (but not yet in force) contains, among other provisions, requirements to limit NOx emissions from marine diesel engines, but sets no limits for other engine pollutants (i.e., HC, CO, PM).[23] A more detailed discussion of the MARPOL 73/78 Annex VI NOx requirements is included in Section II.B.3. below. Table 1 also contains the Annex VI NOx limits, which would apply to new engines greater than 130 kW installed on vessels constructed on or after January 1, 2000, or which undergo a major conversion after that date.

Table 1
Comparison of Numerical Emission Limits:
EPA's Nonroad Tier 1 Levels and MARPOL Annex VI Levels

Agency	Engine Speed	HC (g/kW-hr)	CO (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)
EPA (Proposed)	all	1.3	11.4	9.2	0.54
MARPOL Annex VI (n = engine speed, rpm)	n <130 rpm	None	None	17.0	None
	130 rpm≤n<2000 rpm	None	None	$45*n^{(-0.2)}$	None
	n ≥ 2000	None	None	9.8	None

In response to the 1994 NPRM, several commenters requested that EPA harmonize

[22]See 59 FR 55929 (November 9, 1994).

[23]Other provisions of Annex VI include requirements for ozone-depleting substances, sulfur content of fuel, incineration, VOCs from refueling, and fuel quality. The United States has signed Annex VI, but the Annex has not yet been forwarded to the Senate for its advice and consent.

domestic emission standards for marine diesel engines to the levels being then considered at the IMO, in effect, applying the draft Annex VI limits domestically. Because the draft Annex VI standards (which are the same as those finalized in 1997) were not as stringent as the proposed domestic standards, this was a significant issue. On February 7, 1996, EPA published a Supplemental NPRM to address this and other concerns in more detail.[24] Specifically, EPA identified and requested comment on three alternative harmonization approaches: (1) adopt the draft Annex VI NOx emission standard instead of the standard proposed in the NPRM; (2) retain the average NOx emission standard of 9.2 g/kW-hr proposed by EPA and also adopt the MARPOL Annex VI NOx limit as a cap that no engine could exceed; or (3) determine an appropriate engine speed or engine power output cutoff point such that engines of high horsepower and low and medium speeds would be subject to the draft Annex VI NOx emission limits and engines of low horsepower and high speed would be subject to the 9.2 g/kW-hr average standard proposed by EPA with the 9.8 g/kW-hr Annex VI level as a cap that no engine could exceed. EPA also sought comment on harmonizing the numerical emission limits for other pollutants. Options considered were to drop, retain, or alter the proposed standards for HC, CO, PM, and smoke.

While the development of the national marine rule and the negotiations at the International Maritime Organization continued, EPA began a new action for land-based nonroad diesel engines as part of a new Agency initiative to reduce national NOx and PM emissions from mobile sources. This action, subsequently finalized September 27, 1998, sets more stringent standards for land-based nonroad engines, known as Tier 2 standards (see Section V.A., below).[25] These Tier 2 standards will come into effect as early as 2001 for some engine categories. The rule also includes more stringent Tier 3 standards, which will go into effect subject to a review to be conducted in 2001. That review will be conducted through the normal public rulemaking process. Finally, marine diesel engines less than 37 kW were included with their land-based counterparts in this diesel land-based nonroad rule, with standards to come into effect as early as 1999 for Tier 1 and 2004 for Tier 2.

Also during this time, EPA finalized a rule setting emission standards for new locomotive engines.[26] The locomotive program consists of three separate sets of standards, with applicability of the standards dependent on the date a locomotive is first manufactured. The first set of standards (Tier 0) applies to locomotives and locomotive engines originally manufactured from 1973 through 2001. The Tier 0 standards will be phased in over a two-year period beginning in 2000, and will apply at the time of each remanufacture (as well as at the time of original manufacture for locomotives originally

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[24] See 61 FR 4600 (February 7, 1996).

[25] See 62 FR 50152 (September 24, 1997).

[26] See 62 FR 6365 (February 11, 1997); the final rule was signed December 17, 1997 and is available electronically (see Section VI below).

manufactured in 2000 and 2001). The next set of standards (Tier 1) apply to locomotives and locomotive engines originally manufactured from 2002 through 2004. Such locomotives and locomotive engines will be required to meet the Tier 1 standards at the time of original manufacture and at each subsequent remanufacture. The final set of standards (Tier 2) apply to locomotives and locomotive engines originally manufactured in 2005 and later. Such locomotives and locomotive engines will be required to meet the Tier 2 locomotive standards at the time of original manufacture and at each subsequent remanufacture. The numerical standards are contained in Table 2.

Table 2
Locomotive Standards (line-haul only)

Tier	HC (g/kW-hr)	CO (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)
Tier 0	1.3	6.7	12.7	0.80
Tier 1	0.7	2.9	9.9	0.6
Tier 2	0.4	2.0	7.4	0.27

The land-based nonroad diesel engine and locomotive rules led EPA to reconsider its approach to the control of emissions from marine diesel engines at or above 37 kW. Because of the similarities among land-based nonroad, locomotive, and marine diesel engines, EPA began to consider an alternative program for marine diesel engines based on the technologies that will be used to meet the land-based requirements. As a result, EPA did not take final action on marine diesel engines when it finalized the original marine rule.[27] Instead, EPA published an Advance Notice of Proposed Rulemaking advising interested parties of the change in approach for marine diesel engine emission controls and asking for comment on various aspects of the program under consideration. The program proposed in this action follows from the approach described in the ANPRM, the comments submitted by interested parties, and information gathered by EPA in the meantime.

3. MARPOL Annex VI

In response to growing international concern about air pollution and in recognition of the highly international nature of maritime transportation, the parties to the International Maritime Organization called upon the organization, in 1990, to develop a program to reduce emissions from marine vessels. The IMO's Marine Environmental Protection Committee (MEPC) was instructed to design a program, to become a new Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), that would achieve a 30 percent reduction in NOx and a 50 percent reduction in

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[27] See 61 FR 52087 (October 4, 1996).

SOx emissions when fully phased in. Requirements for ozone-depleting substances, VOCs from cargo compartments on oil tankers, shipboard incinerators, and fuel oil quality rounded out the scope of the program. From the beginning, the engine-specific provisions of proposed Annex VI covered only NOx emissions. No restrictions on PM, HC, or CO emissions were considered. Reductions in SOx emissions were to be pursued through limiting the sulfur content of fuel.

After several years of negotiation, a final version of Annex VI was adopted by the Member States of the IMO at a diplomatic conference on September 26, 1997. However, pursuant to Article 6 of the Annex, it will not go into force until fifteen States, the combined merchant fleets of which constitute not less than 50 percent of the gross tonnage of the world's merchant shipping, have ratified it. The Annex in its entirety will acquire the force of law in the United States only after the Senate (by a vote of two-thirds) concurs in the treaty and the United States deposits its instrument of ratification. Nevertheless, it is expected that ship owners will begin installing compliant engines on relevant ships to comply with the dates set forth in the Annex. Specifically, the NOx provisions contained in Regulation 13 provide that each diesel engine with a power output of more than 130 kW installed on a ship constructed on or after January 1, 2000, or that undergoes a major conversion on or after January 1, 2000, must meet the NOx emission limits described in Table 1, above. This specification of an effective date in Regulation 13 means that, once the Annex goes into effect, Member States will be able to require compliance by any ship constructed on or after January 1, 2000 or by any engine that undergoes a major conversion on or after that date. In other words, once the Annex goes into effect, it will be enforceable back to the dates specified in Regulation 13.

Two other features of Annex VI NOx requirements are noteworthy. First, while the requirements set out in Regulation 13 are expected to extend to all vessels used in the marine environment, a special provision has been included in paragraph 1(b)(ii) to allow Member States to set different standards for engines installed on ships used domestically. EPA intends in this action to take advantage of this provision by setting more stringent national requirements. Second, Regulation 13 is augmented with a separate document, called the NOx Technical Code, which sets out some compliance requirements and test procedures. Through reference in the Annex, the provisions of this Code are made mandatory on Parties to the Annex. A more detailed discussion of the NOx curve and the NOx Technical Code are included in the Draft Regulatory Impact Analysis.

4. State Activities

Section 209 of the Act allows EPA to authorize California to regulate emissions from new motor vehicles and new motor vehicle engines, as well as nonroad engines with the exception of new engines used in locomotives and new engines used in farm and construction equipment rated under 130 kW.[28] So far, the California Air Resources Board (California ARB) has adopted requirements for three groups of nonroad engines: (1) diesel- and otto-cycle small off-road engines rated under 19 kW; (2) new land-based nonroad diesel engines rated over 130 kW; and (3) land-based nonroad recreational engines, including all-terrain vehicles, snowmobiles, off-road motorcycles, go-carts, and other similar vehicles. New requirements that apply to new nonroad SI engines rated over 19 kW were completed by CARB in October 1998. California ARB has also approved a voluntary registration and control program for existing portable equipment, and is currently considering an emission program for recreational gasoline marine engines that may be more stringent than the program finalized by EPA in 1996.

EPA has been in consultation with California state officials and various interest groups to pursue operational measures that would reduce marine engine emissions without setting emission standards. Under investigation are defined traffic lanes, restrictions on engine operation while in port, and other measures that could be tailored to the situation at each port.

5. European Commission Action

The European Commission has proposed emission limits for recreational marine engines, including diesel engines. These requirements would apply to all new engines sold in member countries. The numerical emission limits, shown in Table 3, consist of the Annex VI NOx limit for small marine diesel engines and the rough equivalent of Tier 1 nonroad emission levels for HC and CO. The PM limits, however, are more stringent than Tier 1 nonroad levels, reflecting Europe's greater concern for the visual impacts of diesel emissions. Emission testing is to be conducted using the ISO D2 duty cycle for constant-speed engines and the ISO E5 duty cycle for all other engines. At the current time, the EU has not initiated a separate action for commercial marine diesel engines.

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[28]The Clean Air Act limits the role states may play in regulating emissions from new motor vehicles and nonroad engines. California is permitted to establish emission standards for new motor vehicles and most nonroad engines; other states may adopt California's programs (sections 209 and 177 of the Act).

Table 3
Proposed European Emission Limits
for Recreational Marine Diesel Engines

Pollutant	Emission Limit (g/kW-hr)
NOx	9.8
PM	0.14
HC	1.5*
CO	5.0

*Increases slightly with increasing engine power rating.

C. Industry Characterization

The two groups of companies most likely to be affected by the proposed emission control program are engine manufacturers and vessel manufacturers. This section contains a brief discussion of these entities. A more complete discussion is included in the Draft Regulatory Impact Assessment, which can be found in its entirety in EPA Air Docket A-97-50.

1. Marine Diesel Engine Manufacturers

As discussed in Section IV, the proposed emission control program applies to three categories of marine diesel engines. This discussion reflects those categories.

Category 1 and Category 2 marine diesel engines are often derived from land-based engines. Their production is often referred to as marinization, meaning the land-based engine is modified for use in the marine environment. Marinization can be very a complex process or may be relatively simple. Depending on the degree of change to the base engine, marinization can significantly affect the emission characteristics of an engine. Some of the more complex changes associated with marinization are performed by large engine manufacturers. For these companies, marinization may involve a significant redesign of their land-based product. A less intensive type of marinization is performed by post-manufacturer marinizers. These companies purchase a complete or semi-complete land-based engine from an engine manufacturer and finish or modify it using specially designed parts. The most basic type of marinization is performed by companies that purchase a completed engine from an engine manufacturer and modify it to make it compatible for installation on a marine vessel, without changing the underlying design characteristics or engine calibration. These companies are referred to in this rulemaking as engine dressers. In contrast to the other marinization processes, these changes do not typically affect the emission characteristics of the engine.

Category 3 engines have no land-based mobile source equivalents. These engines are typically designed exclusively for marine purposes. They are often designed for unique applications or unique vessels.

a) Category 1 Engine Manufacturers

Total annual production of Category 1 marine diesel engines in the U.S. is about 15,000 units per year. Of these, commercial propulsion and auxiliary marine engines make up about 30 percent and 10 percent, respectively, of the total production. The remaining engines are used for propulsion in recreational vessels. While the recreational engines are produced in greater quantities, commercial propulsion and auxiliary engines contribute more to air pollution on account of their much greater use.

Commercial applications for these engines are widely varied. Most of these boats are relatively small and operate near the home port. Primary examples of such vessels include fishing boats, crew boats, tour boats, and small tugboats and ferries. Recreational vessels are usually either yachts or are used for recreational fishing. These recreational vessels may in some cases be used for commercial purposes

Engine manufacturers produce the large majority of marine diesel engines, with the remaining engines being produced by post-manufacture marinizers. About a dozen engine manufacturers offer Category 1 engines, though Caterpillar, Cummins, and Detroit Diesel together sell about 80 percent of all marine diesel engines. Fifteen or more companies are either post-manufacture marinizers or engine dressers. Most of these are small businesses with very low sales volumes.

Due to the wide range of companies and their operations, engine maintenance and rebuild practices are far from uniform. Some are serviced regularly by authorized distributors, others are maintained by local for-hire mechanics. Some companies that operate vessels choose to reduce expenses by keeping a staff of mechanics to conduct preventive and routine engine maintenance and, in some cases, complete engine rebuilds. Depending on the size of an operator's fleet, which may run from one to several dozen vessels, and on the strength of the company, there may or may not be an adequate ongoing investment in maintaining engines to maximize long-term engine performance.

b) Category 2 Engine Manufacturers

Large tugboats and fishing boats are the principal applications for Category 2 marine engines. These high-powered engines are used for carrying greater loads, a greater degree of off-shore use and, in many cases, more intensive operations. It is common for companies to own and operate small fleets of these vessels. In addition, multiple Category 2 engines are commonly used for auxiliary power on an ocean-going vessel.

Category 2 engines are derived from or use the same technology as locomotive engines. Not surprisingly, Category 2 engines are produced by the same companies that make locomotive engines, and the segment is characterized by a very small number of manufacturers. General Motors Electromotive Division (EMD) sells the greatest number of Category 2 engines, with additional sales from Caterpillar and a few other companies (mostly from foreign manufacturers).

Post-manufacture marinizers play a role in producing Category 2 marine engines. For example, three authorized EMD distributors take on the responsibility of marinizing engines, overseeing sales distribution, and managing installation and service as needed. Unlike post-manufacture marinizers for Category 1 engines, these companies have sufficient volumes and diversified operations to the point that they are not small businesses.

With prices approaching $1 million for a new engine, there is a strong motivation to maintain and remanufacture engines in the field. Preventive maintenance programs are common, often including extensive ongoing diagnostics for oil quality, fuel consumption, and other engine performance parameters. Engines are often completely remanufactured every five years. Procedures have improved to the point that engine durability on remanufactured engines is no different than on new engines. Since engine remanufacturing costs only 20 to 30 percent as much as buying a new engine, even twenty- or thirty-year-old engines are frequently overhauled to provide dependable power.

c) Category 3 Engine Manufacturers

Category 3 marine diesel engines are the largest mobile source engines addressed by EPA. They are similar in size to land-based power plant generators, and are used primarily for propulsion of ocean-going vessels. There are currently no U.S. manufacturers of Category 3 marine engines. The Agency, however, has identified 22 foreign manufacturers of these engines, a large fraction of which are located in Germany and Japan. In addition, of the Category 3 engine manufacturers identified, only 12 produce engines of their own design. The remainder of the manufacturers produce engines under licensing agreements with other companies that control engine design.

2. Commercial Vessel Builders

The industry characterization for the commercial marine vessel industry was developed by ICF, Incorporated under contract with EPA. A summary of their findings can be found in the Chapter 2 of the Draft RIA. The full report is available from EPA Air Docket A-97-50. The report makes a distinction between two broad groups of commercial vessels, “ships” and “boats,” based on a vessel’s basic dimensions, mission, and area of operation.

a) Commercial Ships

This category is comprised of large merchant vessels, usually exceeding 120 meters (400 feet) in length, that engage in waterborne trade or passenger transport. These ships tend to operate in Great Lakes, coastwise, inter-coastal, noncontiguous, or transoceanic routes. Principal commercial ship types are dry cargo ships, tankers, bulk carriers and passenger ships. Passenger ships include cruise ships and larger ferries. The large majority of commercial ships are foreign-built. There are currently 18 major shipbuilding facilities in the United States, most of which focus on military construction.

b) Commercial Boats

This category is comprised of smaller service and industrial vessels that provide service to commercial ships, industrial vessels, or barges or that perform specialized marine functions. Commercial boats are found mainly in inland or coastal waters. Principal commercial boat types are tugboats, towboats, offshore supply boats, fishing and fisheries vessels, passenger boats, and industrial boats. Passenger boats include crewboats, excursion boats, and smaller ferries. The vast majority of boats used in the United States are also built in the United States. In contrast to the highly concentrated shipbuilding industry, there are several hundred yards that build many different types of boats.

3. Recreational Vessel Builders

While not as numerous as commercial boat builders, there is still a considerable number of recreational boat builders. EPA identified approximately 75 boat builders, not including those that build sailboats. Most of these companies also produce vessels that use gasoline engines. In fact, diesel engines represent a small portion of the overall product offerings for these companies. A small number of recreational boat builders concentrate on diesel engine products. Most companies, however, sell as few as one per month or even one per year. The analysis shows that recreational boat building is concentrated in coastal states with the largest presence in the state of Florida.

Recreational boat building relies more on serial production than does commercial boat building. Users have little, if any, choice in the mechanical features of the vessel and the engine specifically. This is in part due to the way in which these boats are built. Recreational boats are typically made of fiberglass to minimize vessel weight and to facilitate planing. Fiberglass construction has the disadvantage of not offering much flexibility for installing a different engine than that which the vessel was designed to take. Also, planing requires a precise match between the engine and its location in the vessel. Engines are usually purchased from factory authorized distribution centers. The boat builder provides the specifications to the distributor, which helps match an engine for a particular application.

III. Engines Covered

A. General Scope of Application

The scope of application of the proposed emission control program is broadly set by

§213(a)(3) of the CAA, which instructs EPA to promulgate regulations containing standards applicable to emissions from those classes or categories of new nonroad engines and new nonroad vehicles that are found to cause or contribute to ozone or carbon monoxide concentrations in more than one nonattainment area. Generally speaking, then, the proposed rule is intended to cover all new marine diesel engines and new marine vessels that use those engines.

For the purpose of interpreting this scope of application for both engines and vessels, EPA is proposing to generally extend the definition of "new" contained in 40 CFR 89.2 to marine diesel engines at or above 37 kW. Under that definition, an engine is considered new until its legal or equitable title has been transferred and the engine has been placed into service. Because the definition of new in 40 CFR 89.2 applies to both engines and equipment, its extension to the marine sector would extend as well to vessels which, starting with the implementation dates of the proposed emission limits, would be considered new until their equitable or legal title has been transferred to an ultimate purchaser.

EPA seeks comment on whether to augment this definition of "new" by following the approach used in the recently finalized locomotive rule. That rule expands the definition of "new" to also include "a locomotives or locomotive engine which has been remanufactured, but has not been placed back into service."[29] This approach was designed to respond to the very long useful lives of locomotives. Because locomotive engines remain in service for as long as 40 or 50 years, with periodic rebuilds, it was deemed advisable to require remanufactured locomotives to meet a special set of emission standards, depending on the date of their original manufacture. Because marine diesel engines are also kept in service for very long periods of time, such an approach would also lead to additional emission benefits through the application of emission standards on engines that have been put into service but that have subsequently been remanufactured. In fact, this approach may be technologically easier to apply to marine diesel engines than locomotives because of their greater cooling potential. In addition, while not identical, the MARPOL Annex VI provisions contain a similar requirement, which requires engines to meet the NOx emission limits when the engine undergoes a major conversion after January 1, 2000.

At the same time, important obstacles may prevent application of this approach to marine diesel engines. Setting emission limits for remanufactured existing engines may be very disruptive to a large number of small businesses. Also, unlike the railroad industry, companies operating Category 2 marine diesel engines do not rely on a small number of engine remanufacturers to work on their engines. In fact, many of these operators employ their own mechanics to do all maintenance and remanufacturing work. There is accordingly little uniformity in remanufacturing practices across the industry. EPA would need to conduct a major outreach effort to educate the industry about the

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[29]See 40 CFR 92.2.

implications of such a requirement on their business. EPA seeks comment on the feasibility and potential costs and benefits of remanufacturing provisions for existing marine diesel engines. EPA also seeks comment on its authority to establish such programs for each marine engine category, including comment regarding whether marine engines are ever remanufactured to "as new" condition, like locomotive engines.

For the purpose of further clarifying the definition of "new," 40 CFR 89.2 specifies that a nonroad engine, vehicle, or equipment is placed into service when it is used for its functional purposes. For the purpose of applying this criteria to marine diesel engine and new vessels, EPA is proposing that a marine diesel engine is used for its functional purpose when it is installed on a marine vessel. This clarification is needed because some marine diesel engines are made by modifying a highway or nonroad engine that has already been installed on a vehicle or other equipment. In other words, the engine has been transferred to an ultimate purchaser after it is used for its functional purpose as a land-based nonroad engine (for example, on a truck or a backhoe) and is therefore no longer new, but it is later removed for marinization and installation on a marine vessel. While the 40 CFR 89 requirements for land-based nonroad diesel engines do not contain such a requirement, EPA believes it is reasonable to treat these engines as new marine engines when they are installed on a vessel. While the practice of marinizing used highway or nonroad engines may be infrequent, it could become more common if these engines are not subject to the standards in this proposal.

New marine engines are either made in the United States or imported here. It should be noted that not all engines produced in the United States will be subject to the proposed emission limits. Consistent with other mobile source emission control programs, engines intended for sale abroad would be exempt from the requirements.

Engines imported for use in the United States would be covered by the proposed program whether they are imported as loose engines or already installed on a vessel constructed elsewhere. All imported engines would be required to have a certificate of conformity issued by EPA before they could be entered into commerce in the United States, subject to limited exemptions. In addition, EPA proposes to apply the approach contained in its other on-highway and nonroad engine programs, according to which any engine or vessel that is imported into the United States that does not have a currently valid, unexpired certificate of conformity and that was built after the effective date of the applicable standards, would be considered to be new at the time it is imported into the United States and would have to comply with the relevant emission limits in effect at that time. Thus, for example, a marine vessel manufactured in a foreign country in 2004 that is imported into the United States in 2007 would be considered to be new, and its engine would have to comply with the proposed emission limits that would be in effect for MY2007. This provision is important to prevent manufacturers from avoiding the emission requirements by building vessels abroad, transferring their title, and then importing them as used vessels.

Finally, while engines that are intended for export will not be subject to the requirements of the proposed emission control program, marine engines that are exported but that are subsequently re-imported into the United States are intended to be covered. This would be the case when a foreign company purchases marine engines manufactured in the United States for installation on a vessel that will be subsequently exported to the United States. It would also be the case when a foreign company purchases marine engines manufactured in the United States for dressing and subsequent re-exportation to the United States. Engines that are intended for export but that will be re-imported into the United States are intended to be subject to the proposed rule at the time of manufacture, unless the vessel manufacturer, engine dresser, or marinizer intends to re-certify the engines as complying with the proposed emission limits before they enter the United States. Consequently, foreign purchasers who do not wish to recertify the engines will need to make sure they purchase complying engines for those marine vessels or engines they intend to subsequently offer for sale in the United States. Engines intended for export and sale in a foreign country should be easily distinguishable from complying engines because complying engines are required to be labeled as such. Any person who introduces into commerce in the United States a noncomplying engine that is intended for export and use in a foreign country would be subject to civil penalties.

To determine when an engine or vessel will be considered "imported" for the purposes of determining compliance with the proposed emission control program, EPA proposes to follow the approach contained in the Harmonized Tariff Schedule of the United States (HTSUS). According to HTSUS, vessels used in international trade or commerce or vessels brought into the territory of the United States by nonresidents for their own use in pleasure cruising are admitted without formal customs consumption entry or payment of duty.[30] This approach is consistent with the Treasury Department's ruling, which concluded that vessels coming into the United States temporarily as carriers of passengers or merchandise are not subject to customs entry or duty, but if brought into the United States permanently they are to be considered and treated as imported merchandise.

Practically, the above discussion means that engines installed on vessels flagged in another country that come into the United States temporarily will not be subject to the proposed emission limits. This approach is consistent with typical international practices, whereby countries do not generally impose restrictions on the flag vessels of other countries. In recognition of this practice, the numerous Member States of the IMO recently concluded an international agreement stipulating limits for the emission of nitrogen oxides applicable to ships engaged in international voyages. The above discussion also means that engines installed on vessels that are brought into the United States permanently would be subject to the proposed emission control program. EPA seeks comment on this implication and seeks information concerning the frequency with

[30]HTSUS (1994), Additional U.S. Note 1. In particular, cruise ships, ferry boats, cargo ships, barges and "similar vessels for the transportation of persons or goods" are duty free. HTSUS (1994) 8901.

which this situation would occur.

B. Propulsion and Auxiliary Engines

The proposed scope of application is intended to cover all new marine diesel engines at or above 37 kW. This universe of engines includes both propulsion and auxiliary marine diesel engines. Consistent with the definitions in 40 CFR 89, a propulsion engine is intended to be one that moves a vessel through the water or assists in guiding the direction of the vessel (for example, bow thrusters). Auxiliary engines are intended to be all other marine engines.

In the final land-based nonroad rule, EPA determined that a portable auxiliary engine that is used onboard a marine vessel would not be considered to be a marine engine.[31] Instead, a portable auxiliary engine is considered to be a land-based auxiliary engine and is subject to the requirements of 40 CFR 89. To distinguish a marine auxiliary engine installed on a marine vessel from a land-based portable auxiliary engine used on a marine vessel, EPA specified in that rulemaking that an auxiliary engine is installed on a marine vessel if its fuel, cooling, or exhaust system are an integral part of the vessel or require special mounting hardware. All other auxiliary engines are considered to be portable and therefore land-based.

It has become clearer that the differences between marine auxiliary engines and their land-based counterparts may be so small as to suggest that these engines should not be treated differently at all. An alternative approach is to consider all auxiliary engines to be the same and subject them to the land-based nonroad diesel emission requirements and implementation dates (40 CFR Part 89). These two groups of engines are often technologically similar, if not identical, and are dressed for their applications in the same way. The main advantage of this alternative approach is that engine manufacturers would not have to certify these engines twice, once for land-based applications and once for marine applications. A consequence of treating these auxiliary engines as land-based nonroad diesel engines is that there would be some adjustments in emission limits, implementation date, and other provisions. EPA seeks comment on whether the land-based and marine distinctions are necessary for auxiliary engines and on whether EPA should adopt the alternative approach described above.

C. Exemptions

1. Recreational Engines

Marine diesel engines used in recreational and commercial applications are different in several respects. Commercial vessels are designed primarily to efficiently move cargo, either in their own hold or by pushing or pulling other vessels. Consequently, they are

[31] See 63 FR 56967, October 23, 1998.

typically displacement vessels, which means the vessel is pushed through the water. Optimal operations are more a function of hull characteristics, which are designed to reduce drag, than engine size, and these vessels can be powered by engines with power ratings analogous to land-based applications. Commercial vessels are also often heavily used, and their engines are designed to operate for as many as 2,000 to 5,000 hours a year at the higher engine loads needed to push the vessel and its cargo through the water. In addition, these vessels are often designed for specific purposes, and many characteristics, including the choice of engine, are set by the purchaser.

Recreational vessels, in contrast, are designed primarily for speed. To reach high speeds, it is necessary to reduce the surface contact between the vessel and the water, and consequently these vessels typically operate in a planing mode. Planing, in turn, imposes two requirements on vessel design. First, the vessel needs to have a very high power, but lightweight engine to achieve the speeds necessary to push the vessel onto the surface of the water. Consequently, recreational engine manufacturers have focused on achieving higher power output with lighter engines (this is also referred to as high power density). The tradeoff is less durability, and recreational engines are warranted for fewer hours of operation than commercial marine engines. The shorter warranty period is not a great concern, however, since recreational vessels, and therefore their engines, are typically used for fewer hours per year than commercial engines, and spend much less time operating at higher engine loads.

Second, the vessel needs to be as light as possible, with vertical and horizontal centers of gravity precisely located to allow the hull of the vessel to be lifted onto the surface of the water. Consequently, recreational vessel manufacturers have focused on designing very lightweight hulls. They are typically made out of fiberglass, using precisely designed molds. The tradeoff is a reduced ability to accommodate any changes to the standard design. In other words, purchasers are not given much choice as to the design of the vessel and, more particularly, the engine that will be used to power it. Recreational vessels are typically designed around a specific engine or group of engines, and engines that are heavier or that are physically larger cannot be used without jeopardizing the vessel's planing abilities.

EPA has learned that many recreational engines already use the types of technologies that will be necessary to reach the proposed standards. These technologies are typically used to increase the power density of recreational engines. EPA is concerned that redirecting the impact of these technologies toward emission reduction may reduce engine power density. This, in turn, means that recreational vessel builders may have to resort to larger, heavier engines to achieve the same engine power. They may also have to redesign their hulls, and fiberglass molds, to accommodate larger, heavier engines. This can be a costly requirement, since most vessel manufacturers destroy their master hulls once the fiberglass molds are produced.

To allow more time to evaluate the potential impact of the proposed emission limits on the recreational vessel industry, EPA is not proposing to include recreational propulsion marine diesel engines in the proposed emission control program. Instead, EPA intends to consider requirements for those engines in a separate rulemaking. The Notice of Proposed Rulemaking for that recreational marine diesel rule is expected to be signed by November 23, 1999, and the Final Rule is expected to be signed in October, 2000.

EPA considered various methods to distinguish commercial and recreational marine diesel engines for the purpose of this exemption, including relying on physical differences between recreational and commercial engines or their warranty periods. These methods were found to be unsatisfactory. Relying on physical differences between recreational and commercial engines would be difficult, especially since these engines are likely to become more similar as Tier 2 technologies are applied to commercial engines. Relying on warranty periods would be difficult because not all engine manufacturers have the same product ratings with the same warranty periods. Imposing such requirements would unnecessarily impose a degree of uniformity across the industry that may hinder engine design or marketing strategies.

Consequently, EPA is proposing to take a more flexible approach and is proposing to define a recreational marine engine as a marine propulsion engine intended by the engine manufacturer to be installed on a recreational vessel. In other words, a recreational engine would be defined by the engine manufacturer. EPA is also proposing that installation of a new recreational engine on a new nonrecreational vessel would be prohibited, and that all recreational engines be clearly labeled with language that specifies the engine is intended for use only on recreational vessels. Specifically, EPA is proposing the following label language: THIS RECREATIONAL ENGINE DOES NOT COMPLY WITH FEDERAL MARINE ENGINE EMISSION REQUIREMENTS FOR NONRECREATIONAL VESSELS. INSTALLATION OF THIS ENGINE IN ANY NONRECREATIONAL VESSEL IS A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY. Thus, EPA intends that recreational engines can be used only in recreational vessels. It should be noted that the converse of this provision is not true, and that EPA does not intend to prohibit the use of a certified engine on a recreational vessel. In fact, EPA encourages recreational vessel manufacturers to use certified engines due to the beneficial impact it would have on the environment. It should also be noted that this prohibition does not prevent someone from installing an old marine engine in an old vessel.

EPA seeks comment on using a labeling requirement to distinguish recreational engines from commercial engines for the purpose of the exemption, and on whether this approach will be sufficient for preventing the installation of noncertified recreational engines on commercial vessels. EPA also seeks comment on whether a power or displacement cutoff should be also specified, above which engines could no longer be designated as recreational. For example, a power cutoff of 560 kW may be appropriate because larger engines are installed on custom-built recreational vessels that are not subject to the same design constraints as smaller serially-built fiberglass vessels.

For the purpose of the exemption, EPA is proposing to adopt the definition of recreational vessel as that term is defined in 46 U.S.C. 2101. According to that definition, a recreational vessel is a vessel (A) being manufactured or operated primarily for pleasure; or (B) leased, rented or chartered to another for the latter's pleasure. EPA further proposes that, for the purposes of part (B) of this definition, the vessel cannot be leased, rented, or chartered for more than six passengers. EPA is proposing that vessels for hire that can carry more than six passengers, whether or not they ever actually do, be deemed nonrecreational vessels. This is consistent with the definition of recreational vessel for certain Coast Guard safety requirements (See 33 CFR 183.3, 33 CFR 175.3). At the same time, EPA is concerned that including vessels used for hire in the definition of recreational vessel may be inappropriate, since vessels used for hire may be used far more extensively than recreational vessels owned by individuals solely for their own pleasure. Therefore, EPA seeks comment on whether the definition of recreational engine should be extended to vessels for hire.

In addition, to avoid any ambiguities inherent in the term "pleasure," vessels used solely for competition or used at any time in any other way to generate income or revenue in any way not associated with the hiring out of the vessel to other people for their pleasure will not be considered recreational. In other words, if a boat is used for both recreational and commercial purposes, it will be considered a commercial vessel. Thus, for example, a vessel that is used for several weeks a year for lobster fishing and at other time of the year used for recreational purposes will not be considered to be a recreational vessel for the purpose of the proposed program.

2. Modified New Land-Based Engines

A small segment of the marine diesel engine market consists of companies that take a new, land-based engine and modify it for installation on a marine vessel. However, unlike post-manufacture marinizers (described in Section V.L.1., below), some of the companies that modify an engine for installation on a marine vessel do not change it in ways that may affect emissions. Instead, the modifications may consist of adding mounting hardware and a generator or propeller gears. It can also involve installing a new marine cooling system that meets original manufacturer specifications and duplicates the cooling characteristics of the land-based engine, but with a different cooling medium (i.e., water). In many ways, these manufacturers are similar to nonroad equipment manufacturers that purchase certified nonroad engines to make auxiliary engines. This simplified approach of producing an engine can more accurately be described as dressing an engine for a particular application. Because the modified land-based engines are subsequently used on a marine vessel, however, these modified engines would be considered marine diesel engines, which would then fall under the requirements proposed in this document.

To clarify the responsibilities of engine dressers under this rule, EPA is proposing to exempt them from the requirement to certify engines to the proposed standards, provided the following conditions are met.

i) The engine being dressed, (the “base” engine) must be a highway, land-based nonroad, or locomotive engine, certified pursuant to 40 CFR 86, 40 CFR 89, or 40 CFR 92, respectively, or a marine diesel engine certified pursuant to this part.

ii) The base engine’s emissions, for all pollutants, must be at least as good as the otherwise applicable marine diesel emission limits. In other words, starting in 2004, a dressed nonroad Tier 1 engine will not qualify for this exemption, since the more stringent standards for marine diesel engines go into effect at that time.

iii) The dressing process must not involve any modifications that can change engine emissions.

iv) All components added to the engine, including cooling systems, must follow base engine manufacturer specifications.

v) The original emissions-related label must remain clearly visible on the engine.

vi) The engine dresser must notify purchasers that the marine engine is a dressed highway, nonroad, or locomotive engine and is exempt from the requirements of 40 CFR 94.

vii) The engine dresser must report annually to EPA the models that are exempt pursuant to this provision and such other information as EPA deems necessary to ensure appropriate use of the exemption.

EPA is proposing to consider any engine dresser that does not meet these conditions to be an engine manufacturer, and the engine to be a new marine diesel engine, and require their engines to be certified to comply with the provisions of this proposed rule.

It should be noted that an engine dresser that violates the above criteria could be liable under anti-tampering provisions for any change made to the land-based engine that affects emissions. The dresser could also be subject to a compliance action, for selling new marine engines that are not certified to the required emission standards. In addition, the base engine manufacturer could be subject to a compliance action if the engine is found to be out of compliance.

EPA seeks comments on three aspects of this proposed exemption. First, EPA seeks comment on whether highway engines should be included in the set of base engines that can be modified by an engine dresser for marine application without needing further certification. EPA made a previous decision not to allow certified highway engines to be used in nonroad applications without recertifying. This decision was in response to claims that highway engines may not be able to meet applicable emission requirements on the steady-state test cycles applicable to nonroad engines. EPA is nevertheless proposing to allow engine dressers to modify certified highway engines without recertifying them as marine engines, because EPA believes that engine dressers would be unfairly penalized by the constraint that was originally intended for manufacturers selling two versions of their own engines. EPA requests comment on whether it is appropriate to include highway base engines in this exemption.

Second, EPA seeks comment on how to ensure that exempted dressed engines comply with the not-to-exceed requirements described in Section V.F. of this proposal. The base engines certified under 40 CFR 86, 40 CFR 89, or 40 CFR 92 are not subject to these provisions at the present time. Engines that are not subject to the off-cycle emission program may not have test data demonstrating compliance with this requirement.

Finally, EPA seeks comment on whether land-based engines that are credit users (those which have an FEL higher than the standard) should be allowed to benefit from the exemption. According to the above proposed criteria, the base engine's emissions must be at least as good as the otherwise applicable marine diesel emission limits. However, it may be the case that the base engine is a credit user, and that in fact its emissions are not as good as the otherwise applicable marine diesel emission limits, even though it is certified to the same or more stringent emission limits. This is of concern because engine dressers often prepare engines for marine vessels that are used in a particular area of the country. This means that high-emitting dressed engines may be concentrated in just a few port areas. In addition, it is unlikely that enough credit generators will be dressed for marine purposes that will offset the higher emitting credit users. The obvious solution to this problem is to specify that land-based nonroad or locomotive engines whose certification relied on the use of credits cannot benefit from this exemption. However, it is not clear that engine dressers will be able to identify these engines, or to modify their production practices if they happen to rely heavily on them for their own production. EPA seeks comment on this, as well as on any other solutions that will ensure that engines dressed for marine applications do not exceed the marine diesel emission limits.

3. Other Exemptions

EPA is proposing to extend other basic nonroad exemptions to marine diesel engines These include the testing exemption, the manufacturer-owned exemption, the precertification exemption, the display exemption, the national security exemption, and the export exemption described in 40 CFR 89 Subpart J. In addition, EPA seeks comment on an additional exemption for racing and on the scope of the national security exemption. It should be remembered that these exemptions are not necessarily automatic, and that the engine or vessel manufacturer, or ultimate engine owner, may need to apply for them. As part of its approval, EPA may require exempted engines to be labeled.

With regard to the national security exemption, EPA is proposing to apply the approach used in the Agency's existing land-based nonroad and gasoline marine programs (40 CFR 89.908 and 40 CFR 91.1008). According to this exemption, only marine engines used in vessels that exhibit substantial features ordinarily associated with military combat, such as armor and/or permanently affixed weaponry, and which will be owned and/or used by an agency of the federal government with responsibility for national defense, will be considered exempt from the proposed emission control program. No request for an exemption would be necessary for these engines. Thus, according to this approach, engines used on vessels such as aircraft carriers, destroyers, and submarines would automatically be exempt from the proposed program. EPA believes extending the nonroad national security exemption to diesel marine engines is appropriate because the vessels on which these engines are used are designed for specific national security missions, and the exemption will ensure that emission controls do not compromise the ability of these vessels to achieve their military missions. However, it is EPA's understanding that the Department of Defense, and the Navy in particular, adopt emission control technology to the extent it is practical and feasible.

It is EPA's understanding that other public vessels, such as some vessels operated by the Coast Guard or Maritime Administration or vessels used for general cargo purposes by the Navy or other armed service branches, may not have features ordinarily associated with military combat. Such vessels would not qualify for the automatic exemption under the proposed national security exemption. EPA seeks comment on the nature and uses of vessels in such fleets and on the appropriate delineation of the national security exemption. EPA does not believe that application of the emission control technology that will be used to achieve the diesel marine Tier 2 emission limits will hinder the design and use of these vessels. Nevertheless, there may be situations in which an exemption from the emission controls may be necessary. To address this possibility, manufacturers can request a special national security exemption. A manufacturer requesting such an exemption would be required to explain why the exemption is required, and the request would need to be endorsed by an agency of the federal government charged with responsibilities for national defense. EPA requests comment on applying the land-based nonroad and gasoline marine military exemption approach to diesel marine engines or whether these engines are sufficiently different in application from land-based military equipment as to require a different approach. If another approach is more appropriate, EPA requests comment on what that approach should be.

With regard to racing engines, EPA is proposing to allow an exemption for marine diesel engines that are installed on vessels used solely in competition. To limit the application of this requirement to professional racing, EPA is also proposing that the racing exemption may not be given to any vessel that is used for recreational purposes. In other words, high-powered recreational vessels that are not used solely in competition will not be eligible for the racing exemption. The proposed approach is different from the approach used by EPA for SI marine engines (40 CFR Part 91) and land-based nonroad diesel engines (40 CFR Part 89). In those regulations, EPA defined "used solely for competition" based on physical features of the vessel. However, EPA does not believe that marine diesel vessels used solely for competition will necessarily have physical features that are not found on other high performance marine vessels. Thus, in this rulemaking, EPA is proposing to interpret "used solely for competition" literally, such that the exemption would apply only to engines that are, in fact, used solely for competition. The Agency requests comment regarding whether it should also use this literal approach for SI marine engines or land-based nonroad engines.

IV. Engine Categories

The engines that are the subject of this action are very diverse in terms of physical size, emission technology, control hardware, and costs associated with reducing emissions. These differences make it difficult to design one set of emission requirements for all marine diesel engines. For example, numerical emission limits that may be reasonable and feasible for a 37 kW engine used on an 5.5-meter (18-foot) boat may not be reasonable or feasible for a 1,500 kW engine installed on a tug or a 20,000 kW engine installed on an ocean-going container ship. Similarly, numerical emission limits appropriate for very large engines may be not be appropriately stringent for smaller engines, requiring little or no emission reduction.

Consequently, it is necessary to divide marine diesel engines into categories for the purposes of applying emission limits and duty cycles. In developing these categories, EPA had two criteria. First, the categories should allow EPA to take advantage of existing control programs that apply to the base engines from which marine engines are derived. Second, the categories should minimize category straddlers. In choosing how to distinguish between groups of marine diesel engines, EPA considered using rated power, rated speed, total displacement, and several other factors. However, after reviewing the engine parameters of the range of diesel engine models currently being produced, EPA concluded that per-cylinder displacement was the best way to distinguish engine groupings. Per-cylinder displacement is an engine characteristic that is not easily changed and is constant for a given engine model or series of engine models. More specifically, EPA is considering the following categorization scheme, which is summarized in Table 4. EPA requests comment on this categorization scheme.

Table 4
Engine Category Definitions

Category	Displacement per Cylinder	Basic Engine Type
1	disp. < 5 liters (and power ≥ 37 kW)	Land-based Nonroad Diesel
2	5 ≤ disp. < 20 liters	Locomotive
3	disp. ≥ 20 liters	Unique, “Cathedral”

EPA proposes to define Category 1 engines as those marine diesel engines that are rated above 37 kW, but have a per-cylinder displacement of less than 5 liters. This definition is intended to break out the class of marine engines that are serially produced and generally derived from land-based nonroad configurations or use the same emission control technologies. These engines are typically used as propulsion engines on recreational vessels as well as small commercial vessels (fishing vessels, tugboats, towboats, dredgers, etc.) They are also used as auxiliary engines on vessels of all sizes and applications.

EPA proposes to define Category 2 engines as those marine diesel engines with per-cylinder displacement at or above 5 liters and up to 20 liters. This category is intended to include engines that are of similar size and configurations as locomotive engines and use the same or similar emission control technologies. These engines are widely used as propulsion engines in harbor and coastal vessels, and can be used as auxiliary engines on ocean-going vessels and larger tugs.

EPA proposes to define Category 3 engines as those marine diesel engines with a displacement at or above 20 liters per cylinder. These are very large high-power engines that are used almost exclusively for propulsion on vessels engaged in Great Lakes or trans-oceanic trade.

EPA is further proposing to divide Category 1 engines into several subgroups. These subgroups are similar to the land-based nonroad diesel engine subgroups, with one significant change: EPA is proposing to base the marine subgroups on engine displacement rather than engine power. EPA believes this is a more appropriate scheme for two reasons. First, manufacturers sometimes offer different engine models that are the same except for the number of cylinders. These engines may fall into different power groupings by virtue of the added power from adding cylinders. Second, marine engines are often available in a wider range of power than their land-based counterparts. While it may be possible to define wider power bands for marine diesel engine subgroups, it may not be possible to do so without creating phase-in disadvantages for particular companies, especially in comparison to their land-based phase-in schedule. A displacement scheme should minimize these inequities. Consequently, EPA is proposing a displacement approach to defining engine groups, as described in Table 5.

Table 5
Category 1 Engine Groups

Displacement (liters/cylinder)	Approximate Corresponding Power Band from Land-based Nonroad Rulemaking	
	kW	hp
displ.<0.9	37≤kW<75	50≤hp<100
0.9≤displ.<1.2	75≤kW<130	100≤hp<175
1.2≤displ.<1.5	130≤kW<225	175≤hp<300
1.5≤displ.<2	225≤kW<450	300≤hp<600
2.0≤displ.<2.5	450≤kW<560	600≤hp<750
2.5≤displ.<5.0	kW≥560	hp≥750

In selecting the displacement values corresponding with the nonroad power ranges, EPA examined the engine displacement and power characteristics of a wide range of existing engines. The listed displacement values were selected to provide the greatest degree of consistency with the established land-based nonroad engine power groups. The wide range in power ratings for engines with a given per-cylinder displacement, however, led to a high degree of overlap in the attempted correlation between displacement and power rating. As a result, some nonroad engine models that were spread across different power groupings are brought together under a single displacement grouping. This has the potential to move an engine model into a group with somewhat more or less stringent requirements, but in almost all cases there was sufficient overlap to avoid moving a family of engines into an entirely new grouping. The observed overlap highlights the benefit of relying on displacement for a simplified approach. This should give manufacturers opportunity to more sensibly plan an R&D effort to a family of engines that must meet a single set of requirements with a common implementation date.

The most important aspect of defining sub-groups relates to which engines are treated like nonroad diesel engines rated above 560 kW. Emission limits and implementation dates for smaller marine engines are relatively uniform; however, the biggest group of Category 1 engines are subject to less stringent emission limits (for Tier 3) and have more lead time, which makes it especially important to properly separate engines. Investigation of engine models led to three key observations. First, of the engines lines with per-cylinder displacement between 2.5 and 5.0 liter, all had configurations with available power ratings above 560 kW; several of these were much greater than 560 kW. Second, except for one instance, all engines with displacements less than 2.5 liter had configurations with available power ratings below 560 kW; this means that the manufacturers of these engines would have to meet the more aggressive requirements for some of those engines. The only exception is the DDC 149 series engines, which is being replaced with a new engine model. Third, the common practice of bolting two marine engines together would often place the combined engine artificially into the less stringent regime. For example, with respect to emissions and performance, two six-cylinder 300 kW engines bolted together would operate the same as each individual engine. Yet, by doubling the power at the crankshaft, the engine would be subject to less challenging requirements.

The net effect of changing to a displacement-based grouping is hard to quantify. Somewhat greater emission reductions would likely result for the reasons described above, though it is difficult to identify the relative sales volumes of engines that would fall above and below the threshold under both scenarios. The effect on costs is expected to be small. As described above, no engines would be subject to the more stringent standards that would not have a subset of the engine line already subject to those same standards under a power-based grouping arrangement. As a result, there should be no increase in R&D expenses. Variable costs would be incurred for a greater number of engines, but the costs analysis in the Draft RIA makes clear that variable costs play a relatively small role in the overall cost impact of emission requirements. The Draft RIA lists various engine models with their displacement groups. EPA requests comment on this approach to defining Category 1 engine groups. Also, EPA requests comment on whether it would be appropriate to pursue redefinition of the nonroad diesel emission standards into these displacement-based groupings as part of a separate, future rulemaking.

V. Description of Proposed Standards and Related Provisions

In developing this proposal, EPA has developed a comprehensive program to reduce emissions from marine diesel engines. This section describes the proposed emission limits for Category 1 and Category 2 engines. It also sets out provisions that will ensure that engines comply with the emission limits across all engine speed and load combinations, as well as throughout their useful life. Proposed requirements related to test procedures and fuel specifications are also discussed, as well as several certification and compliance provisions. Standards and related provisions for Category 3 engines are described in Section VI, below.

A. Standards and Dates

1. Marine Tier 2 Emission Limits

The Agency's general goal in designing emission control requirements for Category 1 and Category 2 marine diesel engines is to develop a long-term program that will achieve significant emission reductions. In developing such a program, the Agency is guided by §213(a)(3) of the CAA, which instructs EPA to set standards for nonroad engines that "achieve the greatest degree of emission reduction achievable through application of technology the Administrator deems will be available for the engines or vehicles to which such standards apply, giving appropriate consideration to the cost of applying such technology within the period of time available to manufacturers and to noise, energy, and safety factors associated with the application of such technology." The Act also instructs EPA to first consider standards equivalent in stringency to standards for comparable motor vehicles or engines (if any) regulated under §202, taking into consideration technological feasibility, costs, and other factors.

The relevant engines regulated under §202 are on-highway truck engines, both light-duty and heavy-duty. The most recent NOx emission limits set by EPA for these engines range from approximately 2.5 g/kW-hr for heavy-duty trucks to less than 2.0 g/kW-hr for light-duty trucks. After consideration, EPA determined that it is not appropriate to extend the on-highway limits to diesel marine engines for three reasons. First, these emission limits reflect a history of emission control that is not shared by marine diesel engines, which are currently uncontrolled, and it is not clear that marine diesel engines can achieve such stringent emission limits. In comparison, EPA estimates the baseline emission rates of marine diesel engines to be approximately 10.5 g/kW-hr for the smaller marine diesel engines. Second, the duty cycle demands for marine engines are considerably different than those for on-highway trucks, which must be reflected in any choice of emission limits for marine engines. Finally, engines used in marine applications cover a much broader power range. As described elsewhere in this preamble, the marine engines covered by this rule vary in size from 37 kW to in excess of 90,000 kW -- much larger than any on-highway engines, which vary from approximately 50 kW to 500 kW. It may not be possible for the larger marine diesel engines to achieve the limits that were set for a smaller universe of on-highway engines.

Instead of basing the proposed emission limits on on-highway engines, EPA believes it is more appropriate to consider the standards for land-based nonroad diesel engines already promulgated pursuant to §213. This approach is favorable because the vast majority of marine diesel engines are derived from or use the same technologies as land-based engines. As described in the Draft Regulatory Impact Assessment, manufacturers of marine diesel engines typically start with a partially- or fully-completed land-based nonroad diesel engine or, in some cases, a highway diesel engine, and adapt it for use in the marine environment (this process is typically called "marinization").

EPA initially considered extending the land-based nonroad diesel Tier 1 emission limits, as described in the NPRM for new gasoline spark-ignition and diesel compression-ignition engines.[32] These limits are contained in Table 1, above. However, after further consideration, EPA has concluded that those emission limits do not meet the §213 criteria. Available data suggests that marine diesel engines already perform at or near the NOx emission limits (9.2 g/kW-hr). This is not surprising, given that the Tier 1 levels required the application of very simple emission control technology, primarily timing retard and better cooling. In addition, engine manufacturers have been exploring better engine cooling for quite some time in an effort to boost engine power.

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[32] See, 59 FR 55929, November 9, 1994.

Tier 2 nonroad technologies have been applied to marine diesel engines with good results. As described in the Draft Regulatory Impact Analysis, engine manufacturers participating in several California demonstration programs experimented with applying Tier 2 technologies, including electronic controls, better turbocharging, and raw-water aftercooling, to various commercially used engines. These programs have shown that NOx emissions can be reduced by 40 to 60 percent. These results suggest that application of the land-based nonroad Tier 1 emission limits will not achieve the greatest degree of emission reduction achievable, taking into account technological feasibility, costs and other factors, as required by the Clean Air Act. Therefore, EPA is not proposing to extend the land-based nonroad Tier 1 emission limits to marine diesel engines.

At the same time, EPA is concerned about directly applying the land-based nonroad Tier 2 emission limits to marine diesel engines, for at least three reasons. First, the results obtained in the demonstration projects may be better than could be expected over a more general application of these Tier 2 technologies. Specifically, the demonstration projects were carefully controlled programs, and the engines were specially adapted for the participating vessels. These engines may have seen better maintenance or fewer extremes in use than typical marine diesel engines.

Second, manufacturers have indicated that there may be some hardware problems that would have to be worked out before land-based nonroad Tier 2 technologies can be applied to marine diesel engines. For example, achieving Tier 2 emission limits will require a higher use of raw-water aftercooling, which may present some problems for commercial marine engines. As currently designed, these systems can require more frequent maintenance, and may pose some reliability problems. In addition, it is not clear whether split-housing turbochargers can be used extensively with raw-water aftercooling, since the temperature differences between the interior and exterior of the turbocharger can cause material failure.

Finally, and perhaps most importantly, the demonstration projects gathered emissions data primarily for NOx. It is not clear what effect application of these technologies had on PM emissions. This is an important concern because of the NOx/PM tradeoff (as NOx emissions are decreased, PM emissions tend to rise due to the change in combustion temperatures).

To address these concerns while still encouraging the use of land-based nonroad technologies on marine diesel engines, EPA is proposing a two-step approach for Category 1 and 2 marine diesel emission limits. Reflecting the above-described concerns, this approach assumes less than optimal transfer of land-based nonroad technologies to marine engines in the short run. In the long run, however, this approach assumes engine manufacturers will develop ways to fully optimize the transfer of land-based nonroad Tier 2 and Tier 3 emission control technologies to marine diesel engines. This two step approach will also give engine manufacturers more time to resolve mechanical barriers that prevent marine engines from more completely exploiting the water cooling potential of the environment in which they operate (water). Specifically, as described in the technological feasibility section below and the Draft Regulatory Impact Assessment, greater use of raw water and separate system aftercooling will permit marine engines to greatly reduce NOx emissions. Taken as a whole, the proposed emission limits are expected to yield the greatest degree of emission reduction achievable through the application of technology that is expected to be readily available during the time frame covered by the proposal taking into account technological feasibility, costs and other factors, as required by the Clean Air Act.

Table 6 contains the proposed emission limits for marine diesel Category 1 and Category 2 engines. In the first step, which EPA is calling Tier 2 due to the similarity to land-based Tier 2 emission limits, EPA proposes a 7.2 g/kW-hr NOx+HC limit, to apply to both categories of engines. Again, this limit is intended to result in short-term NOx reductions while not requiring manufacturers to completely resolve the transfer of land-based Tier 2 technologies to marine engines. These marine Tier 2 emission limits are proposed to apply beginning in 2004 for engines up to 5 liters per cylinder and 2006 for engines up to 20 liters per cylinder. The staggered dates reflect the added complexities of applying these limits to larger engines. The MARPOL Annex VI NOx limits are also provided in this table for comparison.

Table 6
Proposed Tier 2 Marine Diesel
Emission Limits and Implementation Dates

Subcategory	HC+NOx g/kW-hr	PM g/kW-hr	CO g/kW-hr	Implementation Date
Power ≥ 37 kW 0.5 ≤ disp < 0.9	7.2	0.40	5.0	2004
0.9 ≤ disp < 1.2	7.2	0.30	5.0	2004
1.2 ≤ disp < 1.5	7.2	0.20	3.5	2004
1.5 ≤ disp < 2.0	7.2	0.20	3.5	2004
2.0 ≤ disp < 2.5	7.2	0.20	3.5	2004
2.5 ≤ disp < 5.0	7.2	0.20	3.5	2006
5.0 ≤ disp < 20.0	7.2	0.27	2.0	2006
MARPOL Annex VI, for comparison purposes (NOx only)				
n ≥ 2000 rpm	9.8	None	None	1/1/2000
130 rpm≤n<2000 rpm	$45*n^{(-0.2)}$	None		1/1/2000
n <130 rpm	17.0	None	None	1/1/2000

It is expected that marine diesel engines can achieve this emission limit through the application of electronic controls and better cooling, perhaps supplemented by some degree of timing retard. EPA is also proposing emission controls for PM and CO, that are equal to the land-based nonroad and locomotive limits for these pollutants, depending on the size of the engine. EPA does not believe it is necessary to relax these limits relative to the land-based programs. Due to the NOx/PM tradeoff, the higher NOx emission limit should ensure the feasibility of achieving the PM limits as well. Diesel engines inherently have low CO emissions, and the proposed limits are intended to serve as a cap.

EPA is proposing new requirements designed to ensure that the standards are met during real world operation as well as under laboratory tests (see Section V.F. “Not-to-Exceed Requirements”). According to these requirements, marine engines may not exceed the applicable emission limits by more than 25 percent while the engine is operated in any load/speed combination contained in a specified not-to-exceed (NTE) zone. EPA believes that the technology listed above that will be used to meet the proposed standards will be sufficient to meet the combined emission limits and NTE requirements. While the NTE transient operation requirements have an effect on PM emissions, this is not expected to pose any design difficulties. Marine operations typically have only limited transience and the NTE requirements are designed so that a short transience can be averaged into a minimum operating period.

EPA believes the proposed marine diesel emission limits set out in Table 6 strike the appropriate balance, taking into consideration the recently finalized Tier 2 emission limits that apply to the land-based nonroad engines from which many if not most diesel marine engines are derived and the special characteristics of marine diesel engines that may make achievement of those limits difficult. EPA requests comments on these proposed marine diesel Tier 2 limits. Specifically, it may be the case that the barriers to applying land-based technologies to marine diesel engines, including recreational engines, are smaller than expected, and that the land-based nonroad emission control program is, in fact, technologically feasible. In that case, extension of the land-based programs would be the appropriate approach according to the criteria set out in the Clean Air Act. The land-based Tier 2 emission limits are contained in Table 7. EPA also seeks comment on whether the superior cooling potential of marine diesel engines would permit even lower emission standards for NOx and PM at an acceptable cost.

Table 7
Land-Based Nonroad Tier 2
Emission Limits and Implementation Dates

Subcategory	HC+NOx g/kW-hr	PM g/kW-hr	CO g/kW-hr	Implementation Date
Power ≥ 37 kW 0.5 ≤ disp < 0.9	7.5	0.4	5.0	2004
0.9 ≤ disp < 1.2	6.6	0.3	5.0	2003
1.2 ≤ disp < 1.5	6.6	0.2	3.5	2003
1.5 ≤ disp < 2.0	6.4	0.2	3.5	2001
2.0 ≤ disp < 2.5	6.4	0.2	3.5	2002
2.5 ≤ disp < 5.0	6.4	0.2	3.5	2006
5.0 ≤ disp < 20.0	0.4, 7.4	0.27	2.0	2005

2. Marine Tier 3 Emission Limits

In the long run, it is anticipated that greater experience with emission controls and the transfer of land-based technologies to marine engines will make more stringent emission limits feasible. For this second step, which EPA is calling Tier 3 due to the similarity to land-based Tier 3 emission limits, EPA proposes a 3.0 g/kW-hr NOx +HC limit, to apply to marine diesel engines up to 2.5 l/cyl beginning in 2008. EPA believes this emission limit should be achievable within the time available through more aggressive engine cooling and use of electronic engine controls. At the same time, and similar to the Tier 2 limits, there are uncertainties regarding the transferability of land-based Tier 3 technologies to these marine diesel engines. Because more complete information on the technologies that will be used to achieve these limits for land-based engines will not be available for several years, EPA intends to reconsider these marine Tier 3 limits as part of a feasibility review, to take place in 2003. At that time, EPA will examine the extent to which the proposed Tier 3 standards are technologically feasible and otherwise appropriate under the Clean Air Act. The marine diesel Tier 3 NOx+HC limits are set out in Table 8.

Table 8
Proposed Tier 3 Marine Diesel HC+NOx
Emission Limits and Implementation Dates*

Subcategory	HC+NOx g/kW-hr	Implementation Date
Power $\geq$ 37 kW 0.5 $\leq$ disp < 0.9	4.0	2008
0.9 $\leq$ disp < 1.2	4.0	2008
1.2 $\leq$ disp < 1.5	4.0	2008
1.5 $\leq$ disp < 2.0	4.0	2008
2.0 $\leq$ disp < 2.5	4.0	2008
2.5 $\leq$ disp < 5.0	5.0	2010
5.0 $\leq$ disp < 20.0	5.0	2010

*Note: These limits are subject to a 2003 Feasibility Review.

EPA also seeks comment on whether the marine diesel Tier 3 limits should follow the land-based nonroad limits, set out in Table 9. As discussed under the Tier 2 limits, above, it could be the case that transferring land-based nonroad Tier 3 technologies will be easier than anticipated. This, in combination with the superior cooling potential of marine engines, may make achievement of the land-based Tier 3 standards feasible. If adopted, these land-based limits would be subject to review in the 2003 feasibility study.

Table 9
Land-Based Nonroad Tier 3
Emission Limits and Implementation Dates

Subcategory	HC+NOx g/kW-hr	Implementation Date
Power $\geq$ 37 kW 0.5 $\leq$ disp < 0.9	4.7	2008
0.9 $\leq$ disp < 1.2	4.0	2007
1.2 $\leq$ disp < 1.5	4.0	2006
1.5 $\leq$ disp < 2.0	4.0	2006
2.0 $\leq$ disp < 2.5	4.0	2006

*Note: These limits are subject to a 2003 Feasibility Review.

As noted in Table 8, EPA is also proposing Tier 3 emission limits for Category 1 marine diesel engines at or above 2.5 l/cyl. and Category 2 marine diesel engines. Tier 3 emission controls are necessary for these engines because of the importance of their emissions to local ozone inventories. Marine diesel engines at or above 2.5 l/cyl are an important part of the emission inventory of many cities with commercial ports.[33] While the population of engines in these areas may be smaller than land-based nonroad equipment or locomotives, it is also the case that their use is much more concentrated, being limited to port areas. In addition, many cities with commercial ports are in nonattainment areas, and the second phase emission limits will be an important tool to help them reduce local ozone levels.

EPA did not set Tier 3 emission limits for land-based nonroad engines at or above 560 kW or for locomotives, due to the limited cooling potential of those engines. These engines are typically installed in relatively restrictive spaces, and are unable to take full advantage of air-to-air cooling systems. However, EPA believes that marine diesel engines at or above 2.5 l/cyl should be able to meet more stringent Tier 3 emission limits because they can take advantage of the medium in which they operate, water, to achieve better engine cooling and additional NOx reductions. At the same time, the ability of these larger engines to take full advantage of raw water aftercooling or separate system aftercooling is complicated by the same constraints that must be overcome for the smaller

[33] Category 1 and 2 marine diesel engines make up approximately 6 percent of the NOx emission inventory for San Diego, 5 percent for San Francisco and 2 percent for Los Angeles-South Coast, Baltimore, and Chicago. See Commercial Marine Vessel Contributions to Emission Inventories, Final Report, Submitted by Booz-Allen & Hamilton, Inc., October 7, 1991.

engines. To accommodate concerns about overcoming this constraint, as well as uncertainty over the transferability of more efficient cooling technology from the smaller to the larger marine diesel engines, EPA intends to review the Tier 3 emission limits for engines at or above 2.5 liters per cylinder as part of the 2003 Feasibility Review. EPA seeks comment on the proposed Tier 3 limits for these engines, concerning both their stringency and implementation dates.

Finally, EPA will also examine the need to set more stringent PM limits as part of the 2003 Feasibility Review. Consideration of more stringent PM standards will be a function of, but not depend exclusively on, the ease with which engines are expected to reach the NOx+HC limits, the extent to which the higher sulfur content of marine diesel fuel can be accommodated, whether the land-based nonroad diesel engine PM limits are revised as part of that category's 2001 feasibility review, and the cost of such limits.

Before making a final decision in the 2003 review, EPA intends to issue a proposal and offer an opportunity for public comment on whether the Tier 3 standards continue to be consistent with the requirements of the Act and continue to be technologically feasible for implementation according to the proposed schedule. Any Tier 3 PM standards would also be proposed in such a notice. Following the close of the comment period, EPA intends to issue a final Agency decision.

If by 2003 EPA finds the emission standards are not feasible according to the proposed schedule, or are otherwise not appropriate under the Act, EPA will propose changes to the program, possibly including adjustments to the levels of the standards. The adjusted standards may be more or less stringent than those already established, including the possibility of a new emission standard for particulate matter. The standards finalized in the rulemaking initiated by this proposal would stay in effect unless revised by the subsequent rulemaking procedure.

3. Interim Emission Limits

As noted above, EPA considered but rejected proposing land-based nonroad Tier 1 emission limits to marine diesel engines. Such emission limits would not be cost-effective because marine diesel engines often already meet the Tier 1 emission limits, and a Tier 1 program would simply impose a certification burden for minimal emission benefits.

At the same time, however, EPA is concerned about leaving these engines uncontrolled until the implementation dates of the marine Tier 2 standards (2004 for engines up to 2.5 l/cyl and 2006 for engines between 2.5 and 20 l/cyl). As noted above, these engines can be a considerable source of NOx and PM emissions in port and coastal areas, many of which are in nonattainment zones.

This problem may be alleviated, however, by the MARPOL Annex VI emission control program. Regulation 13 of Annex VI to the International Convention on the

Prevention of Pollution from Ships calls for engines installed on ships constructed on or after January 1, 2000, to meet emission limits similar in stringency to the land-based nonroad Tier 1 limits. Although the Annex VI emission limits are not enforceable until the Annex goes into effect (12 months after it is ratified by 15 countries representing at least 50 percent of the gross tonnage of the world's merchant shipping), it is expected that ship owners will begin to comply with these emission limits in 2000 to avoid future enforcement actions. According to Regulation 13(1)(b)(ii), the Annex requirements will apply even to ships operated in domestic waters unless a country takes action to the contrary. It is expected that the MARPOL Annex VI program will act as a cap on NOx emissions, since engine manufacturers will have to make compliant engines available for installation on ships beginning January 1, 2000. At the same time, however, there is some concern about compliance with these limits because they will not be enforceable until the Annex goes into effect. In addition, the international inspection program, when it goes into effect, will cover only engines installed on ships at or above 400 gross tons.[34]

EPA seeks comment on whether it is appropriate to rely on the MARPOL Annex VI program as an interim cap on NOx emissions, with no formal emission limits or certification program set by EPA. Also, EPA seeks comment on how to verify that engine manufacturers are, in fact, complying with the MARPOL Annex VI program prior to the implementation date of Annex VI.

4. Total Hydrocarbons

EPA proposes to use total hydrocarbons (HC) rather than nonmethane hydrocarbons in its emission standards for marine diesel engines. This is consistent with locomotive standards but inconsistent with land-based nonroad standards. Methane was considered to be removed from the regulated pollutants since it is significantly less reactive than other hydrocarbons in the formation of ozone. However, for diesel engines, methane only makes up about two percent of the total hydrocarbons. In addition, HC generally makes up less than five percent of the combined HC+NOx from a marine diesel engine. The combination of these two factors renders the methane fraction of the exhaust insignificant when compared to the significant digits in the proposed HC+NOx standard.

The advantage of using total hydrocarbons rather than nonmethane hydrocarbons in the proposed standard is that it simplifies the emission measurement. To determine NMHC, both HC and methane must be measured. Methane is generally measured by speciating total hydrocarbons using a gas chromatograph, which can be time consuming and costly. In addition, by using total hydrocarbons for the standard for all marine diesel engines, the standards are consistent for Category 1 and Category 2.

B. Crankcase Emissions

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[34] See Regulation 5, Surveys and Inspections, of the Annex.

EPA is proposing to require that all marine diesel engines either have closed crankcases (where blowby gases are routed into the engine intake air stream), or route all blowby gases into the engine exhaust stream for inclusion in all exhaust emission measurements. Manufacturers would be allowed flexibility for routed blowby gases in in-use configurations, provided that the blowby gases could be readily routed into the exhaust for any in-use test. This approach is similar to the approach used by EPA for locomotives. The purpose of this proposed requirement is to provide manufacturers the incentive to reduce crankcase emissions to the maximum extent possible, or to eliminate them all together.

C. Smoke Requirements

EPA is not proposing smoke requirements for marine diesel engines. Marine diesel engine manufacturers have stated that many marine diesel engines, even though currently unregulated, are manufactured with smoke limiting controls at the request of the engine purchasers. Users seek low smoke emissions both because they dislike the residue smoke emissions leave on decks and because they can be subject to penalties in ports that have smoke emission requirements. In many cases, marine engine exhaust gases are mixed with water prior to being released. This practice reduces the significance of smoke emissions since smoke becomes significantly less visible. Moreover, the Agency believes that the PM standards being proposed here will have the effect of limiting smoke emissions as well. EPA requests comment on these views and, specifically, on whether there is a need at this time for additional control of smoke emissions from Category 1 marine engines, and if so, what the appropriate limits should be.

If a smoke limit is desirable, EPA also requests comment on what the test procedure should be. There is currently no test procedure that can be used to measure compliance with a smoke limit. Most propulsion marine engines operate over a torque curve governed by the propellor. Consequently, a vessel with an engine operating at a given speed will have a narrow range of torque levels. Some large propulsion marine engines have variable-pitch propellers, in which case the engine operates much like constant-speed engines. It should be noted, however, that ISO is working on a proposal for marine diesel engine smoke test procedures. A copy of a recent draft is being placed in the docket for this rulemaking. As this procedure is finalized by ISO, and emission data become available, EPA may review the issue of smoke requirements for all marine diesel engines. EPA requests comment on this overall approach to smoke emissions from marine diesel engines, as well as comment on the draft ISO procedures.

D. Alternative Fuels

EPA has determined that the proposed standards should apply to marine diesel engines, without regard to the type of fuel that they use. This is consistent with nonroad diesel engine regulations of 40 CFR Part 89. It is also generally consistent with the locomotive regulations; however, the locomotive regulations apply even more broadly because they also include spark-ignited engines. EPA recognizes that few, if any, alternative-fueled marine engines are currently being manufactured, but believes that it is appropriate to make clear to manufacturers what standards will apply to such engines should they be produced.

The broad applicability of the proposed standards raises two potential issues. The first issue is related to the form of the HC standards. In its regulation of highway vehicles and engines (59 FR 48472, September 21, 1994), the Agency determined that it is not appropriate to apply total hydrocarbon standards to engines fueled with natural gas (which is comprised primarily of methane), but rather that nonmethane hydrocarbon (NMHC) standards should be used. Thus, EPA is setting NMHC+NOx standards for compression-ignition natural gas-fueled marine engines. These NMHC+NOx standards are numerically equivalent to the HC+NOx standards proposed for diesel engines. Similarly, EPA has determined that alcohol-fueled engines should be subject to HC-equivalent (HCE) standards instead of HC standards (54 FR 14426, April 11, 1989). HC-equivalent emissions are calculated from the oxygenated organic components and non-oxygenated organic components of the exhaust, summed together based on the amount of organic carbon present in the exhaust. (The reader is referred to the April 11, 1989 final rule for more information regarding the determination of HC-equivalence.) EPA is proposing these approaches because it has previously determined that these approaches will result in the most equivalent stringency for all fuel types.

The second issue raised by the regulation of is related to the need for slightly different test procedures for alternative-fueled engines. This issue is being resolved in this rulemaking by referencing the test procedures found in 40 CFR Parts 89 and 92, both of which include flexibility for testing alternative-fueled engines. EPA requests comment on whether more specific regulation is needed for marine engines.

E. Test Procedures

For this marine regulation, EPA is proposing to use previously established test procedures for diesel nonroad engines. Specifically, EPA is proposing that Category 1 marine engines be tested using the land-based nonroad test procedures of 40 CFR Part 89, and that Category 2 marine engines be tested using the locomotive test procedures of 40 CFR Part 92. There are two reasons for using this approach. First, most manufacturers of marine compression-ignition engines also manufacture land-based engines and will be equipped to test engines using these test procedures. Second, marine compression-ignition engines are fundamentally similar to their land-based counterparts, and it is therefore appropriate to measure their emissions in the same way. At the same time, some changes are necessary, EPA is proposing the modifications to these test procedures described below.

1. Duty cycles

The duty cycle used to measure emissions is intended to simulate operation in the field. Testing an engine for emissions consists of exercising it over a prescribed duty cycle of speeds and loads, typically using an engine dynamometer. The nature of the duty cycle used for determining compliance with emission standards during the certification process is critical in evaluating the likely emissions performance of engines designed to those standards.

To address operational differences between engines, EPA is proposing different duty cycles for different types of compression-ignition marine propulsion engines. EPA is proposing that propulsion engines that operate on a fixed-pitch propeller curve be certified using the International Standards Organization (ISO) E3 duty cycle. This is a four-mode steady-state cycle developed to represent in-use operation of marine diesel engines on vessels 24 meters in length and larger. The four modes lie on an average propeller curve based on the vessels surveyed in the development of this duty cycle. Another duty cycle, ISO E5, was developed to represent in-use operation of smaller marine diesel engines; this cycle is similar to the E3 except that an idle mode is added and the cycle is more heavily weighted towards lower power modes. The E3 is designed for engines used to propel vessels greater than 24 meters in length while the E5 is designed for engines used to propel vessels less than 24 meters in length. The attractiveness of the E3 duty cycle is that, according to EPA's inventory analysis, the majority of HC+NOx emissions from marine diesel engines are generated by engines on vessels more than 24 meters in length. By choosing a single cycle to represent all propeller-curve marine diesel engines, EPA hopes to reduce certification burdens for marine engines that are used in vessels both over and under 24 meters in length.

EPA is proposing that fixed-speed marine propulsion engines with variable-pitch propellers be certified on the ISO E2 duty cycle. This duty cycle is also a four-mode steady-state cycle. It uses the same power and weighting factors as the E3 cycle, but the engine is operated in each mode at rated speed.

EPA is also proposing that variable-speed marine propulsion engines with variable-pitch propellers be certified on the ISO E2 duty cycle. These engines are designed to operate near their power curve to maximize fuel efficiency. In general, these engines will operate at a constant speed except when maneuvering in port. Because of the expense of the system, variable-speed engines are rarely used with variable-pitch propellers. ISO does not have a test duty cycle specifically designed for these engines. However, because most of their operation is at constant speed, EPA is proposing that these engines certify using the E2 duty cycle. EPA proposes that the speed setting for testing should coincide with the speed setting at which the engine would spend most of its time in use.

For auxiliary engines, EPA is proposing that constant-speed auxiliary engines be certified to the ISO D2 duty cycle and that variable-speed auxiliary engines be certified to the ISO C1 duty cycle. These duty cycles are consistent with the requirements for land-based nonroad diesel engines. More detail on the proposed duty cycles is contained in the Draft Regulatory Impact Analysis (Draft RIA) associated with this proposal. EPA requests comment on the appropriateness of the proposed duty cycles.

Under the provisions of the land-based nonroad rule, engine manufacturers have the option to petition for their marine engines to be included in land-based engine families. EPA is not proposing this flexibility for propulsion marine engines because the "not-to-exceed" provisions described below require the use of the marine duty cycles.

For larger marine engines, conventional emission testing on a dynamometer becomes more difficult because of the size of the engine. Often engine mock ups are used for the development of these engines where a single block is used for many years and only the power assembly is changed out. EPA proposes that for Category 2 engines, certification tests may be performed on these engine mock ups provided that their configuration is the same as that of the production engines. In addition, for larger Category 2 marine engines, EPA requests comment on whether or not single-cylinder tests should be allowed for certification testing. Assuming that each cylinder in an engine is equivalent, a single-cylinder test should give the same brake-specific emission results as a full engine test.

2. In-Use Testing

As with its other federal mobile source programs, EPA retains the authority to perform in-use testing on marine engines to ensure compliance in use. This testing may include taking in use marine diesel engines out of the vessel and testing them in a laboratory, as well as field testing of in use engines in the vessel, in a marine environment. EPA's proposal specifies the equipment and related procedures for use in laboratory based testing. EPA is not at this time, however, specifying similar provisions for field testing. EPA expects that the capabilities of field testing equipment will increase over time, and it is better to allow this to occur without attempting to pick testing technologies at this time, or interfere with this development process.

Field testing data will be used by EPA in two ways. First, it may be used as a screening tool, with follow up laboratory testing where appropriate. Second, it may be used directly as a basis for compliance determinations, when the field testing itself provides reliable information from which conclusions can be drawn regarding what laboratory based emissions levels would be. The probative value of field test data is expected to increase over time, as the capabilities of field testing equipment are developed. The flexibility in testing that these approaches provide will allow EPA to most efficiently conduct in use testing, and will also address those situations where it is physically or otherwise impossible to remove an engine from a marine vessel for testing in a laboratory.

For compression-ignition marine engines that expel exhaust gases under water or mix their exhaust with water, EPA proposes to require that the engines be equipped with an exhaust sample port where a probe can be inserted for in-use exhaust emission testing. It is important that the location of this port allow a well mixed and representative sample of the exhaust. The purpose of this proposed provision is to simplify in-use testing. EPA requests comment on the proposed in-use testing provisions.

3. Test Fuel

Section 206(h) of the Clean Air Act requires EPA to ensure that the test procedure, including the test fuel, adequately represent in-use operation. To facilitate the testing process, EPA specifies a test fuel that is intended to be representative of in-use fuels. Engines would have to meet the standard on any fuel that meets the proposed test fuel specifications, with one modification as described later. This section describes the test fuel EPA is proposing for Category 1 and Category 2 engines. This test fuel is to be used for all testing associated with the regulations proposed in this document, to include certification, production line and in-use testing, as well as any NTE testing.

EPA is proposing that the recently finalized test fuel specifications for nonroad diesel engines be applied, with a modification to the sulfur specification as described later, to both Category 1 and 2 marine diesel engines. EPA believes that largely adopting the nonroad fuel will simplify development and certification burdens for marine engines that are developed from land-based counterparts. The proposed test fuel for marine diesel engine testing has a sulfur specification range of 0.03 to 0.80 weight-percent (wt%), which covers the range of sulfur levels observed for most in-use fuels. Manufacturers are generally responsible for ensuring compliance with the emission standards using any fuel within this range. Thus, they will be able to harmonize their marine test fuel with U.S. highway (<0.05 wt%), nonroad (0.03 to 0.40 wt%), locomotive (0.2 to 0.4 wt%) and European testing (0.1 to 0.2 wt%). The full range of proposed test fuel specifications are presented in Chapter 3 of the Draft RIA.

EPA is proposing a higher upper limit for the marine diesel engine sulfur specification (0.8 wt%) than was recently finalized for land-based nonroad engines (0.4 wt%) because there is some information available that suggests that marine fuels may have higher sulfur contents than land-based diesel fuels.[35] Using ASTM specification D 2069 as a guide, EPA considered choosing an upper limit of 1.5 wt% sulfur. Although 1.5 wt% may be appropriate based on the ASTM specification, EPA is proposing that this upper limit on sulfur content be 0.8 wt% because PM can not accurately be measured using the proposed testing procedures using fuels with a sulfur content higher than 0.8 wt%.[36] EPA requests comment on whether it is appropriate to limit the test fuel specification in this way due to this testing constraint.

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[35] "Final Report: 1996 American Petroleum Institute/National Petroleum Refiners Association Survey of Refining Operations and Product Quality" suggests that actual marine diesel fuels may have sulfur contents somewhat higher than general nonroad diesel fuels. ASTM specification D 2069 includes a specification for general purpose marine distillate fuel with a maximum sulfur content of 1.5 wt%.

[36] "Exhaust Gas Emission Measurements: A Contribution to a Realistic Approach," D. Bastenhof, dieselMAC, May, 1995.

The proposed PM standards were largely determined to be feasible based on the feasibility of the corresponding standards for land-based nonroad and locomotive applications, which have a 0.4 wt% sulfur upper limit for the test fuel. Since PM emissions are somewhat fuel sulfur-dependent, EPA does not believe that it is appropriate to require compliance with the PM standards using fuel with a sulfur content above 0.4 wt%. It is for this reason that EPA is proposing to allow a correction of PM emissions for tests that are run using fuel with a sulfur content greater than 0.4 wt%. Thus, the measured PM emissions for any test performed using fuel with a sulfur content of greater than 0.4 wt% would be corrected to the level that would have been measured if the fuel had a sulfur content of 0.4 wt%. The proposed correction method is that used for land-based nonroad engine testing. EPA requests comment on whether this correction method is accurate and appropriate for this application.

It is EPA's intent that engines be designed for the whole range of in-use fuels and that any testing conducted by EPA would use test fuels typical of in-use fuels. Unfortunately, the test procedure currently limits the Agency from reaching this objective for marine diesel engines if in-use fuels do in fact have sulfur levels as high as the current ASTM specifications allow. EPA requests comment on whether currently available marine fuel has a sulfur content significantly higher than land-based nonroad fuel. EPA will be investigating marine fuel further and is requesting information on the specifications that are used in use. It is EPA's intent to develop test procedures that will allow for the accurate measurement of PM emission over the entire range of in-use fuel characteristics. If successful, the Agency would intend to broaden the range of certification fuel to reflect the full range of in-use fuels. Any efforts to do so would consider the impacts on the appropriateness and feasibility of the PM standards and would likely be undertaken in the planned 2003 technology review for the Tier 3 standards.

EPA requests comment on all aspects of its proposed test fuel provisions. EPA is also interested in obtaining more information on the specifications of marine fuel used in Category 2 marine engines. Essentially, this proposal assumes that Category 2 marine engines are operating on a distillate fuel. The Agency requests comments on this approach and on how often residual fuels or residual fuel blends are burned in Category 2 engines.

4. Adjustable Parameters

Marine diesel engines are often designed with adjustable components, to allow the engine to be adjusted for maximum efficiency when used in a particular application. This practice simplifies marine diesel engine production, since the same basic engine can be used in many applications. While EPA recognizes the need for this practice, EPA is also concerned that the engine meet the proposed emission limits throughout the range of adjustment. Therefore, and consistent with the locomotive rule, the Agency is proposing that manufacturers specify in their applications for certification the range of adjustment for these components across which the engine is certified to comply with the applicable emission standards, and demonstrate compliance across that range.

Practically, this requirement means that a manufacturer would specify a range of fuel injection timing, for example, over which the engine would comply with the emission standards. This range could be designed to account for differences in fuel quality. Operators would then be prohibited by the anti-tampering provisions from adjusting engines outside of this range.

Ideally, to ensure that engines are always operated within the specified range of adjustment, marine diesel engine manufacturers should be required to design their engines to prevent adjustments outside the specified range. However, EPA recognizes that it may be necessary to adjust injection timing or other adjustable parameters outside the originally specified control range during engine remanufacture to accommodate engine wear. There are at least two alternative solutions to this problem. First, engine manufacturers could be required to set a range of adjustments that would accommodate changes necessary at the time the engine will be remanufactured. Alternatively, compliance with the range of adjustments could be ensure through anti-tampering provisions, with the requirement that the new range of adjustments be specified at the time of remanufacture. EPA seeks comments on these and other approaches to ensure that engines with adjustable parameters meet the proposed emission requirements.

5. Definition of Rated Speed

The definition of rated speed, where speed is the angular velocity of an engine's crankshaft (usually expressed in revolutions per minute, or rpm) is an important aspect of the test cycles and "not-to-exceed" (NTE) zones proposed in this document. In the past, EPA has expected engine manufacturers to declare reasonable rated speeds for their engines; however, EPA is concerned that some manufacturers may have declared rated speeds that are not really representative of the operating characteristics of a particular engine in order to influence the parameters under which their engines could be certified. Under EPA's highway transient duty cycle, manufacturers would likely receive a NOx emission benefit if they declared a rated speed that was higher than the actual rated speed of the engine. Under EPA's nonroad and proposed marine steady-state duty cycles, manufacturers would likely receive a NOx emission benefit if they declared a lower rated speed. In addition, a low declared rated speed would shrink a marine engine's NTE zone.

Currently, U.S. highway and nonroad diesel engine regulations specify two slightly different ways to determine rated speed. EPA's highway heavy-duty diesel regulation defines rated speed as the manufacturer's specified rated speed, as defined at 40 CFR 86.082-2, or calculated speed, whichever yields the higher speed. The calculated speed in the highway rule is determined by averaging the minimum and maximum speeds at which 98% of maximum power is generated. This calculation can yield unreasonable speeds in some high-torque-rise engines. EPA's nonroad rule defines rated speed as the maximum full-load governed speed for governed engines and the speed of maximum horsepower for ungoverned engines. The International Standards Organization (ISO-8178) defines a diesel engine's rated speed as the speed at which, according to the statement of the engine manufacturer, rated power is delivered. This is similar to the International Maritime Organization's definition; the crankshaft revolutions per minute at which the rated power occurs as specified on the nameplate and in the Technical File of the marine diesel engine.

To determine a single rated speed definition that encompasses the complete range of engine operation, EPA analyzed the maximum-power versus speed curves from eleven highway and nonroad engines. These engines were all similar to marine engines and they may be used in marine applications. EPA observed that most mechanically governed engines had distinct governor droops at speeds slightly higher than the speed at maximum power. High-torque-rise engines, however, had gradual decreases in power beyond the maximum-power speed, followed by a steep rate of governor droop. Furthermore, some electronically governed engines had multiple rates of power decrease between the maximum-power speed and the onset of governor droop. See Figure 1 for an illustration of four different maximum-power versus speed curves.

Based on this analysis, EPA proposes that the rated speed of any engine shall be defined at the single point on an engine's maximum-power versus speed curve that lies farthest away from the zero-power, zero-speed point on a normalized maximum-power versus speed plot. In other words, consider straight lines drawn between the origin (speed = 0, load = 0) and each point on an engine's maximum-power versus speed curve (see Figure 1). Note that the maximum-power versus speed curve is normalized so that 100% power and 100% speed are set at the maximum power and maximum-power speed point. Under this proposal, rated speed would be defined at that point where the magnitude (length) of this line reaches its maximum value. The magnitude of this line, called $Rated\_Speed_{factor}$ in this rule, is calculated by using the following equation:

$$Rated\_Speed_{factor} = \sqrt{(\%\,Maximum\_Power\_Speed)^2 + (\%\,MaximumPower)^2}$$

Rated speed shall be the speed value of the data point that returns the maximum value of $Rated\_Speed_{factor}$.

EPA proposes the following procedure to determine rated speed:

1. Generate maximum-power versus speed data points by using the appropriate method defined in 40 CFR 86.1332-90. EPA recognizes that 40 CFR 86.1332-90 does not address the issue of electronic engines that vary injection timing, rate shaping, exhaust gas recirculation, and variable-nozzle turbocharging with respect to their operating conditions. These engines' maximum-power versus speed curves can vary as a function of the method in which the curves are determined (i.e., transient curve generation versus steady-state curve generation). EPA proposes that the engine operation generating the maximum $Rated\_Speed_{factor}$ shall be the operation under which rated speed is determined.

EPA seeks comment on this proposal.

2. Compare power values to determine the point where power is a maximum.

3. Normalize power values with respect to maximum power.

4. Normalize speed with respect to the speed at which maximum power is generated.

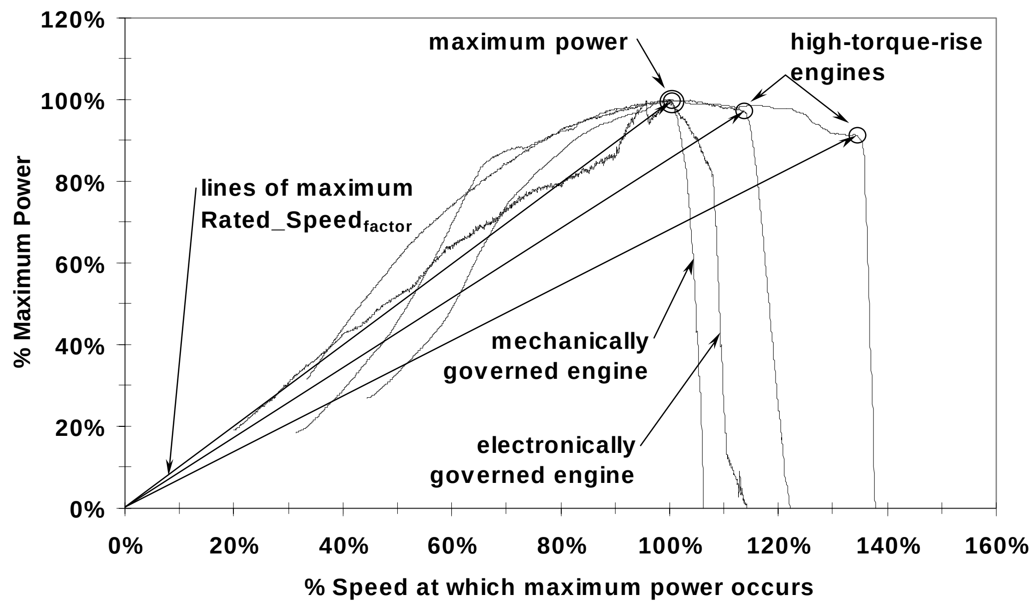
5. Calculate the $Rated\_Speed_{factor}$ for each normalized data point.

6. Compare all $Rated\_Speed_{factor}$ values to determine the maximum value of $Rated\_Speed_{factor}$.

7. The speed at which maximum $Rated\_Speed_{factor}$ occurs shall be the rated speed for certification and NTE zone testing.

Examples of results from this calculation are illustrated by circles superimposed on four maximum-power versus speed curves in Figure 1. EPA seeks comment on this proposal.

Figure 1: Maximum-power versus speed curves (normalized). Rated speed points are circled.



F. Not-to-Exceed Requirements

EPA's goal is to achieve control of emissions over the broad range of in-use speed and load combinations that can occur on a vessel so that real-world emission control is achieved, rather than just controlling emissions under certain laboratory conditions. An important tool for achieving this goal is an in-use program with an objective standard and an easily implemented test procedure. Historically, EPA's approach has been to set a numerical standard on a specified test procedure and rely on the prohibition of defeat devices to ensure in-use control over a broad range of operation not included in the test procedure.

No single test procedure can cover all real world applications, operations, or conditions. Yet to ensure that emission standards are providing the intended benefits in use, the Agency must have a reasonable expectation that emissions under real world conditions reflect those measured on the test procedure. The defeat device prohibition is designed to ensure that emissions controls are employed during real world operation and not just under laboratory or test procedure conditions. However, the defeat device prohibition is not a quantified standard and does not have an associated test procedure, so it does not have the clear objectivity and ready enforceability of a numerical standard and test procedure. As a result, the current focus on a standardized test procedure makes it harder to ensure that engines will operate with the same level of control in the real world as in the test cell.

Because the E3 duty cycle uses only four modes on an average propeller curve to characterize marine diesel engine operation, EPA is concerned that an engine designed to the duty cycle would not necessarily perform the same way over the range of speed and load combinations seen on a vessel. The E3 duty cycle is based on an average propeller curve, but a propulsion marine engine may never be fitted with an "average propeller." For instance, a light vessel with a planing hull may operate at lower torques than average while the same engine operated on a heavy vessel with a deep displacement hull may operate at higher torques than average. This can largely be a function of how well the propeller is matched to the engine and vessel. A planing hull vessel can operate at high torques at low speed prior to planing. In addition, the E3 duty cycle only includes steady-state operation while some transience is seen in use.

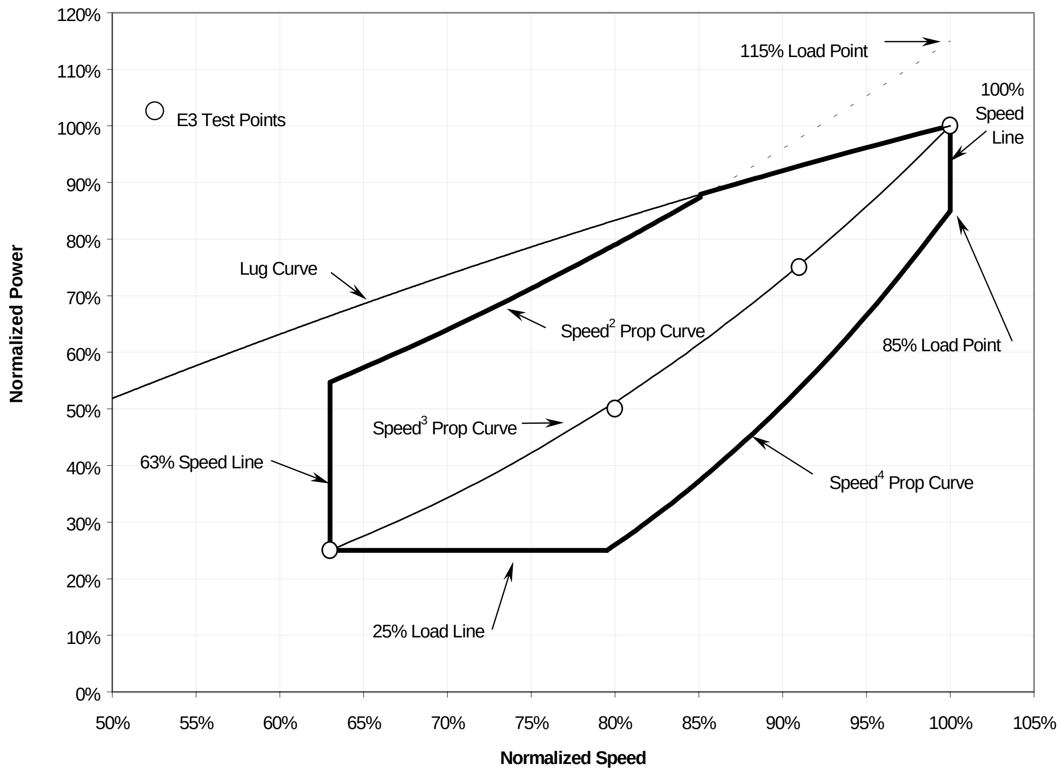
To ensure that propulsion emissions are controlled from marine diesel engines over the full range of speed and load combinations seen on vessels, EPA proposes to establish a zone under the engine's power curve where the engine may not exceed a specified emissions limit, for any of the regulated pollutants, under any operation that could reasonably be expected to be seen in the real world. In addition, EPA proposes that the whole range of real ambient conditions be included in this "not-to-exceed" (NTE) zone testing. The NTE zone, limit, and ambient conditions are described below.

EPA believes that there are significant advantages to taking this sort of approach. The test procedure is very flexible so it can represent any and all in-use conditions (ambient and operation). Therefore, the NTE approach takes all of the benefits of a numerical standard and test procedure and expands it to cover a broad range of conditions. Also, laboratory testing makes it harder to perform in-use testing since either the engines would have to be removed from the vessel or care would have to be taken that laboratory-type conditions can be achieved on the vessel. With the NTE approach, in-use testing and compliance become much easier since emissions may be sampled during normal vessel use. Because this approach is objective, it makes enforcement easier and provides more certainty to the industry of what is expected in use versus over a fixed laboratory test procedure.

Even with the NTE requirements, EPA believes that it is still important to retain standards based on the steady-state duty cycles. This is the standard that EPA expects the certified marine diesel engines to meet on average in use. The NTE testing is more focused on maximum emissions for segments of operation and should not require additional technology beyond what is used to meet the proposed standards. EPA believes that basing the emissions standards on a distinct cycle and using the NTE zone to ensure in-use control creates a comprehensive program. In addition, the steady-state duty cycles give a basis for calculating credits for use in the averaging, banking, and trading program.

The proposed NTE zone for marine diesel engines that would certify using the E3 duty cycle is illustrated in Figure 1 and is defined by the power curve of the engine up to rated speed. This zone is based on the range of conditions that a marine diesel propulsion engine could typically see in use. EPA is proposing a similar approach for engines certified using the constant-speed E2 duty cycle. In this case, the “not-to-exceed” zone is at the speed for which the engine is designed to operate for loads ranging from 25 to 100 percent of maximum load at that speed. More detail on the development of the boundaries and conditions associated with the proposed NTE zones may be found in Chapter 3 of the Draft RIA. EPA requests comment on the NTE zones.

Figure 2: **Illustration of "Not to Exceed" Zone**



EPA proposes the limit on emissions within the NTE zones to be 1.25 times the standard (or FEL if ABT is used) for all of the regulated pollutants (HC, NOx, CO, PM). The standard itself is intended to represent the average emissions under steady-state conditions. Since it is an average, some points can be higher, some lower, and the manufacturer will design to maximize performance and still meet the engine standard. The NTE limit is on top of this. It is designed to make sure that no part of the engine operation and that no application goes too far from the average level of control. Data presented in Chapter 3 of the Draft RIA shows that the proposed limit of 1.25 times the standard is feasible for marine diesel engines, yet challenging because of variations in emissions at high versus low speeds and loads for some engines. The proposed limit is consistent with the enforcement policy currently in place for the highway heavy-duty diesel program.[37] However, the proposed marine NTE zones are much smaller than for highway heavy-duty diesel engines due to the smaller range of operation typically seen in use.

Although transient operation would be included in the NTE testing, only operation

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[37] "Heavy-duty Diesel Engines Controlled by Onboard Computers: Guidance on Reporting and Evaluating Auxiliary Emission Control Devices and the Defeat Device Prohibition of the Clean Air Act," U.S. EPA, October 15, 1998.

that would reasonably be expected to be seen in use would be included. Therefore, engine testing may include transient speed and load operation. Examples of this type of transience would be bringing a vessel to plane or changing speeds. Because the majority of marine operation is fairly steady, EPA believes that the NTE testing should allow for short emissions spikes under transience. Engine testing may not include transient operation that cannot be replicated by similar engines as installed on actual vessels in use, since those are operations that the engine is not designed for and is not expected to see in-use. Therefore, there would be no in-use emission impact from such operations. To ensure that a short transience does not unfairly give high results, EPA proposes that the emissions sampling must be at least over a 30 second time period. This 30 second sampling period should be long enough to allow an emissions spike to be averaged out while still retaining a short enough period to look at a specific type of operation. EPA proposes that an acceleration associated with bringing a vessel to plane be eligible for inclusion in any NTE type testing regardless of whether it falls within the NTE zone shown in Figure 1.

The NTE standards are proposed to apply under any ambient air conditions. Within the following air temperature and humidity ranges, no corrections will be allowed to account for the effects of temperature or humidity on emissions: 13-35°C for ambient air temperature and 7.1-10.7 grams water per kilogram of dry air for humidity. Ambient water temperature must be in the range of 5-32°C during NTE testing. In addition, the engines must comply with the standards for the full range of test fuel specifications.

The defeat device provisions established for highway and nonroad engines are proposed to apply to marine diesel engines in addition to the NTE requirements. A design in which an engine met the standard at the steady-state test points but was intentionally designed to approach the NTE limit everywhere else would be considered to be defeating the standard. Electronic controls that recognize when the engine is being tested for emissions and adjust the emissions from the engine would be another example of a defeat device, regardless of the emissions performance of the engine.

EPA is aware that marine diesel engines may not be able to meet the emissions limit under all conditions. Specifically, there are times when emissions control must be compromised for startability or safety. EPA is not proposing that engine starting be included in the NTE testing. In addition, EPA manufacturers would have the option of petitioning the Administrator to allow emissions to increase under engine protection strategies such as when an engine overheats.

EPA proposes to allow manufacturers to petition to adjust the size and shape of the NTE zone for certain engines if they can certify to the Agency that the engine will not see operation outside of the revised NTE zone in use. This way, manufacturers could avoid having to test their engines under operation that they would never see in use. However, manufacturers would still be responsible for all operation of an engine on a vessel that would reasonably be expected to be seen in-use and would be responsible for ensuring that their specified operation is indicative of real-world operation. In addition, if a manufacturer designs an engine for operation at speeds and loads outside of the proposed NTE zone (i.e., variable-speed engines used with variable-pitch propellers), the manufacturer would be responsible for notifying EPA so that their NTE zone can be modified appropriately to include this operation.

EPA is interested in refining the NTE concept for marine diesel engines prior to the final rule where appropriate. One concern may exist for mechanically controlled engines that are only capable of a fixed injection timing. It may be difficult for these engines to achieve a flat emissions profile, especially at low speeds and loads where brake-specific emissions are often higher. One potential option for addressing this problem would be to split the NTE zone into two subzones with a relaxed cap at lower speeds and loads. EPA requests comment on this option and on any other technical options and improvements to the off-cycle provisions as proposed.

The Engine Manufacturers Association has presented an off-cycle concept to EPA in response to concerns and concepts raised by the Agency. This concept is in a briefing format and may be found in the docket.[38] In the EMA concept, the NTE zone emissions limit is based on the emissions at individual steady-state test modes with limits on the interpolated values between the modes rather than a flat cap. In the highway policy, EPA uses a concept similar to this but it is in addition to a flat emissions limit. The NTE zone described by EMA is smaller than the proposed zone, and the emissions limit is higher on average. EPA requests comment on this approach and on whether or not it is needed in addition to the proposed approach as in the on-highway program.

EPA is not proposing an NTE limit, at this time, for engines certified using the D2 or C1 test duty cycles. EPA does not yet have enough data on the operating characteristics of auxiliary engines to determine NTE zones and associated limits for these engines. However, EPA is gathering data and intents to evaluate the NTE concept for auxiliary engines. This effort will likely be combined with the efforts begun to evaluate off-cycle emission for land-based nonroad engines. EPA requests comment on appropriate NTE zones and limits for auxiliary engines.

G. Voluntary Low-Emitting Engine Program

Officials representing certain cities, states, or regions in the U.S. have expressed interest in developing incentive programs to encourage the use of engine technologies that go beyond federal emission standards. Some of these technologies have already undergone significant development. In the final rule for land-based nonroad diesel engines, EPA included a program of voluntary standards for low-emitting engines, referring to these as "Blue Sky Series" engines (63 FR 56967, October 23, 1998). EPA is proposing similar voluntary standards as part of this rulemaking. The program, if

[38] Engine Manufacturers Association, “EMA Alternative Proposal for Controlling ‘Off-Cycle’ Emissions from Marine Engines,” September 25, 1998.

successful, will lead to the introduction and more widespread use of these low-emission technologies.

Ongoing research has led to much improved prospects for a variety of low-emitting diesel engine technologies. Technology developments to meet upcoming emission requirements for highway diesel engines are expected to substantially reduce emissions without relying on exhaust aftertreatment. Much of this technology development forms the basis for setting the emission limits described in this proposal, but EPA believes that manufacturers may be prepared to more aggressively transfer some of these advanced technologies to marine engines. The motivation to exceed emission requirements could either be to gain early experience with certain technologies as a strategy to ensure long-term control of quality, or as a response to external incentives.

In addition, alternative fuels and exhaust aftertreatment options continue to expand as companies further develop technologies for reaching very low emission levels. For example, some particulate traps are now designed for regeneration without an active control system, sometimes using fuel-based catalyst materials to reduce regeneration temperature requirements. Selective catalytic reduction, long used very effectively in stationary source applications, is now in several demonstration marine vessels. Plasma and thermoelectric techniques are also under consideration for large particulate and NOx reductions. EPA is very interested in seeing a demonstration of the emission-control potential for these engines in marine applications, especially related to the capability of maintaining low emission levels over extended in-use operation.

As with the land-based rule, EPA proposes that Tier 3 emission levels, where applicable, are the appropriate level for defining Blue Sky Series engines. For PM emissions, a calculated level corresponding to a 40 percent reduction beyond Tier 2 levels is proposed as a qualifying level for Blue Sky Series engines (see Table 10). While the Blue Sky Series emission limits are voluntary, a manufacturer choosing to certify an engine under this program would be required to meet all the provisions established to demonstrate compliance with these limits, including allowable maintenance, warranty, useful life, rebuild, and deterioration factor provisions.

Table 10
Voluntary Emission Standards (g/kW-hr)

Rated Brake Power (kW)	HC+NOx	PM
power $\geq$ 37 kW displ.<0.9	4.0	0.24
0.9$\leq$displ.<1.2	4.0	0.18
1.2$\leq$displ.<2.5	4.0	0.12
2.5$\leq$displ.<5.0	5.0	0.12
5.0$\leq$displ.<20	5.0	0.16

The Blue Sky Series program would begin immediately upon promulgation and would continue through the 2007 model year. EPA would evaluate the program to determine if it should be continued for 2008 and later engines, and if so, whether any changes are needed. This evaluation will be considered as part of the 2003 Feasibility Review.

Creating a program of voluntary standards for low-emitting engines, including testing and durability provisions to help ensure adequate in-use performance, will be a major step forward in advancing innovative emission control technologies, because EPA certification will provide protection against false claims of environmentally beneficial products. For the program to be most effective, however, incentives for the production of these engines must be created as well.

The Agency is concerned that such incentive programs not lead to a net detriment to the environment through the double-counting of benefits. EPA has therefore concluded that manufacturers choosing to sell an engine with the Blue Sky Series designation should not generate averaging, banking, and trading credits for demonstrating compliance with EPA programs. Other groups would then be free to design credit programs without concern for any double-counting or other unintended effect of overlapping programs. EPA solicits comment on the Blue Sky Series approach for marine diesel engines generally and on its interaction with the ABT program.

In addition to credit-based programs, the Agency sees substantial potential for users and state and local governments to establish incentive programs. For example, state or local governments or individual ports may be able to add incentives for introducing low-emitting engine technologies in harbor and other coastal vessels. The Agency solicits ideas that could encourage the creation of these incentive programs by users and state and local governments. EPA also solicits comment on additional measures that could be taken at a federal level to encourage development and introduction of these engines.

H. Durability

To achieve the full benefit of the emissions standards, manufacturers must design and build engines with durable emission controls. This means that manufacturers are responsible for the emission results for the engines they produce throughout their useful life.[39] It is also necessary to encourage the proper maintenance and repair of engines throughout their lifetime. The goal is for engines to maintain good emission performance throughout their in-use operation. Therefore, EPA believes it is necessary to adopt measures to address concerns about possible in-use emission performance degradation. The proposed durability provisions, described below, are intended to help ensure that engines are still meeting applicable standards in use. The specific areas of the durability program focused on here are useful life, warranty periods, deterioration factors, allowable maintenance intervals, and rebuilding requirements. Most of these provisions are carried over from the land-based or locomotive programs. EPA seeks comments on all aspects of this durability program.

1. Useful Life

Useful life is the period during which the marine engine is required to meet the emission standards. For Category 1 engines, EPA is proposing a useful life of 10 years or 10,000 hours of operation. This proposal is slightly different from the 10 years or 8,000 hours of operation finalized for land-based nonroad engines, to reflect the different usage pattern for marine engines. Specifically, the 10,000-hour requirement is based on an expected five-year period until the first time the engine is rebuilt, and an expected usage rate of 2,000 hours per year. EPA requests comment on this proposed useful life for Category 1 engines.

For Category 2 engines, EPA is proposing a useful life of 10 years or 20,000 hours of operation. This proposal differs from the 10 years or 7.5 MW-hours per horsepower useful life recently finalized for locomotive engines to reflect the hours of operation instead of MW-per-horsepower requirement for locomotive engines. This is because marine engine operation is typically monitored using hour meters rather than MW-hour meters. In this case, the 20,000-hour requirement for marine engines is calculated based on an operating rate of 4,000 hours of use per year, with five years between rebuilds. This hour value is less than would be obtained from 7.5 MW-hrs per horsepower and an average duty cycle for a locomotive. Using these values would result in a useful life value of about 30,000 hours. This is nevertheless appropriate, since locomotives

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[39]This is different from the approach used in MARPOL Annex VI, according to which manufacturers must ensure their engines meet the emission limits at the time of certification but ship owners become responsible for their continued compliance with the limits. Under that program, compliance is verified during flag-state and port-state inspections.

typically receive significantly more maintenance in use, and are operated for longer periods between rebuilds. EPA requests comment on the proposed useful life for Category 2 engines.

Table 11
Proposed Useful Life and Warranty Periods

Category	Useful Life		Warranty Period	
	Hours	Years	Hours	Years
Category 1	10,000	10	5,000	5
Category 2	20,000	10	10,000	5

The above approach of basing useful life on time to first rebuild was chosen because it is difficult to justify holding the engine manufacturer responsible for an engine's emissions after the engine is rebuilt. The original engine manufacturer has little, if any, control over the rebuild process, and the rebuilding process often includes changes to the engine that may have an effect on emissions. At the same time, however, these engines are often kept in service much longer than the proposed useful life. Median values for service lives are 15 years for Category 1 propulsion engines and 23 years for Category 2 engines. These longer service lives mean that the engine may be exempt from in-use testing for more than half its service life. EPA therefore believes it is important to be able to conduct recall testing on these engines throughout the established useful life period. Also, EPA requests comment on whether useful life should be based on the average time to first rebuild, or whether EPA should attempt to regulate emissions beyond the anticipated point of first rebuild, either through an extended useful life specification or some other means.

2. Warranty Periods

Tied to the useful life is the minimum warranty period imposed under the Clean Air Act. The proposed warranty periods for marine diesel engines are based on the ratio of useful life and warranty periods established for land-based nonroad engines. Specifically, EPA is proposing a warranty period of 5,000 hours or 5 years for Category 1 engines, and 10,000 hours or 5 years for Category 2 engines. EPA requests comment on this approach, or whether the locomotive approach based on one-third of the engine's useful life should be used.

EPA is also proposing defect reporting requirements. Consistent with the provisions that apply to highway and land-based nonroad engines, these provisions require Category 1 engine manufacturers to report to EPA whenever a manufacturer identifies a specific emission-related defect in 25 or more engines. However, EPA is proposing to specify a lower threshold of 10 engines for Category 2 marine engines, which is the same limit as applies to locomotives.

3. Deterioration Factors

To further ensure that the proposed emission limits are met in use, EPA proposes to require the application of a deterioration factor (DF) to Category 1 and Category 2 marine diesel engines in evaluating emission control performance during the certification and production-line testing process. The emissions from new engines are adjusted using the DF to account for potential deterioration in emissions over the life of the engine due to aging of emission control technologies or devices. The resulting emission level is intended to represent the expected emissions at the end of the useful life period. Specifically, EPA believes that the ability of new emission control technologies, such as aftertreatment, sophisticated fuel delivery controls, and some cooling systems, to reduce emissions declines as these systems age. The DF is applied to the certification emission test data to represent emissions at the end of the useful life of the engine. Currently, DFs are required for highway heavy-duty engines, nonroad land-based engines, and locomotive engines. EPA is proposing to extend this approach to marine diesel engines as well. EPA requests comment on all aspects of the proposed DF provisions, described below.

EPA is proposing that marine diesel engine DFs be determined by the engine manufacturers in accordance with good engineering practices. Consistent with the land-based nonroad and locomotive programs, EPA is not proposing a specified procedure. The DFs, however, would be subject to EPA approval, and must be consistent with in-use test data. Additionally, the DF should be calculated for the worst-case engine calibration offered within the engine family.[40]

It is not EPA's intent to require a great deal of data gathering on engines that use established technology for which the manufacturers have the experience to develop appropriate DFs. New DF testing may not be needed where sufficient data already exists. However, EPA is proposing to apply the DF requirement to all engines so that EPA can be sure that reasonable methods are being used to ascertain the capability of engines to meet standards throughout their useful lives.

Consistent with the land-based engine programs, EPA proposes to allow marine diesel engine manufacturers the flexibility of using carryover and carryacross of durability emission data from a single engine that has been certified to the same or more stringent standard for which all of the data applicable for certification has been submitted. In addition, EPA seeks comment on whether this flexibility should be extended to allow deterioration data from highway or nonroad engines to be used for similar marine diesel engines. EPA is concerned that DFs calculated for land-based engines may not be the same as for marine engines, due to their different operating environments and duty cycles.

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[40]The worst case would be the engine calibration expected to generate the highest level of emission deterioration over the useful life, using good engineering judgement.

Finally, EPA is proposing that DFs be calculated as an additive value (i.e., the arithmetic difference between emission level at full useful life and the emission level at the test point) for engines without exhaust aftertreatment devices. In contrast, DFs should be calculated as a multiplicative value (i.e., the ratio of the emission level at full useful life to the emission level at the test point) for engines using exhaust aftertreatment devices. This is consistent with the DF requirements applicable to other diesel engines, based on observed patterns of emission deterioration.

4. Allowable Maintenance Intervals

In the highway, land-based, and locomotive rules, EPA requires manufacturers to furnish the ultimate purchaser of each new nonroad engine with written instructions for the maintenance needed to ensure proper functioning of the emission control system. Generally, manufacturers require the owners to perform this maintenance as a condition of their emission warranties. If such required maintenance is more than the engine owner is likely to perform due to cost or inconvenience, then in-use emissions deterioration can result. Consequently, in both the nonroad and highway rules, EPA imposes limits on the frequency of maintenance that can be required of the engine owners for emission-related components; these limits also apply to the engine manufacturer during engine certification and durability testing. Further, the performance of maintenance would be considered during any in-use recall testing conducted by the Agency.

Consistent with the land-based nonroad rule, EPA is proposing minimum allowable maintenance intervals for Category 1 and Category 2 marine diesel engines, to ensure that their emission control technologies are practical in use. The proposed minimum intervals are very similar to those required for nonroad and highway diesel engines (40 CFR 89.109; 40 CFR 86.094-25). Alternatively, EPA could adopt the locomotive approach of not precisely defining minimum intervals for adjustment, cleaning, repair, or replacement of various components but, instead, merely requiring engine manufacturers to specify these minimum maintenance intervals at the time of certification, subject to EPA approval. EPA is not, however, proposing the locomotive approach in which locomotive owners who fail to properly maintain a locomotive will be subject to civil penalties for tampering. EPA requests comment on these approaches for allowable maintenance intervals and the appropriateness of extending the land-based intervals to marine diesel engines.

5. Rebuilt Engines

It is common for marine diesel engines to be rebuilt several times during the course of their lifetimes. Similar to land-based nonroad engines, EPA has two concerns regarding the rebuilding of marine diesel engines. First, EPA is concerned that during engine rebuilding, there may not be an incentive to check and repair emission controls that do not affect engine performance. Second, EPA is concerned that there may be an incentive to rebuild engines to an older configuration due to real or perceived performance penalties associated with technologies that would be used to meet the standards proposed in this notice. Such practices would likely result in increased emissions.

To address these concerns, EPA is proposing to extend the land-based nonroad rebuild requirements to marine diesel engines. Specifically, EPA proposes that the parties involved in the process of rebuilding or remanufacturing engines must follow specific provisions to avoid tampering with the engine and emission controls. Like the nonroad requirements, the applicability of these provisions is based on the build date of the engine. The rebuild requirements would apply to any engine built on or after the date that new standards apply to that engine's specific category or group, regardless of the emission levels that the individual engine is designed to achieve. The proposed provisions for rebuilding are as follows:

(1) EPA proposes that, during engine rebuilding, parties involved must have a reasonable technical basis for knowing that the rebuilt engine is equivalent, from an emissions standpoint, to a certified configuration (i.e., tolerances, calibrations, and specifications).

(2) When an engine is being rebuilt and remains installed or is reinstalled in the same vessel, it must be rebuilt to a configuration of the same or later model year as the original engine. When an engine is being replaced, the replacement engine must be an engine of (or rebuilt to) a configuration of the same or later model year as the original engine.

(3) At the time of rebuild, emission-related codes or signals from on-board monitoring systems may not be erased or reset without diagnosing and responding appropriately to the diagnostic codes. Diagnostic systems must be free of all such codes when the rebuilt engines are returned to service. Further, such signals may not be rendered inoperative during the rebuilding process.

(4) When conducting an in-frame rebuild or the installation of a rebuilt engine, all emission-related components not otherwise addressed by the above provisions must be checked and cleaned, repaired, or replaced where necessary, following manufacturer recommended practices.

Under this proposal, any person or entity engaged in the process, in whole or part, of rebuilding engines who fails to comply with the above provisions may be liable for tampering. Parties would be responsible for the activities over which they have control, so there may be more than one responsible party for a single engine in cases where different parties perform different tasks during the engine rebuilding process (e.g., engine rebuild, full engine assembly, installation). EPA is not proposing any certification or in-use emissions requirements for the rebuilder or engine owner. EPA requests comment on the appropriateness of applying this rebuild program to marine diesel engines.

EPA is proposing to adopt modest record keeping requirements that EPA believes are in line with customary business practices. The records would be kept by persons involved in the process of marine diesel engine rebuilding or remanufacturing and would include the hours of use accumulated on the engine at time of rebuild and a list of the work performed on the engine and related emission control systems, including a list of replacement parts used, engine parameter adjustments, design element changes, and work performed as described in item (4) of the rebuild provisions above. EPA proposes that such records be kept for two years after the engine is rebuilt.

Under this proposal, parties would be required to keep the information for two years but would be allowed to use whatever format or system they choose, provided that the information can be readily understood by an EPA enforcement officer. EPA proposes that parties would not be required to keep information that they do not have access to as part of normal business practice. In cases where it is customary practice to keep records for engine families rather than specific engines, where the engines within that family are being rebuilt or remanufactured to an identical configuration, such record keeping practices are proposed to be satisfactory. Rebuilders would be able to use records such as build lists, parts lists, and engineering parameters that they keep of the engine families being rebuilt rather than on individual engines, provided that each engine is rebuilt in the same way to those specifications. EPA requests comments on the appropriateness of the proposed record keeping requirements, including whether the records should be kept for a longer period of time, such as for five years.

6. Replacement Engines

As noted elsewhere in this discussion, an important constraint on the ability to replace a marine diesel engine concerns the ability to remove the engine from the vessel. In many cases, the vessel is built around the engine and removal is difficult if not impossible. Nevertheless, there may be situations in which a marine diesel can or must be removed from a vessel, to be replaced with a different engine. Under these requirements, whenever a compliant engine is removed from a vessel, the replacement engine must meet the emission requirements that were in effect at the time the vessel was built. For example, any engine installed on a vessel built in 2008 must comply with the requirements proposed in this action, regardless of whether it is installed in 2008 or any year thereafter. The intent of this requirement is to ensure that vessel owners cannot evade the proposed emission requirements by installing a noncomplying engine on their vessel after the vessel is placed into service. These provisions also allow, in some cases, engine manufacturers to produce new replacement engines of an older model that do not comply with the otherwise applicable standards, provided that the new engines meet the emission standards that applied to the engines being replaced. However, manufacturers would only be allowed to produce such engines in cases where it was necessary for reasons such as space constraints. Consistent with replacement engine provisions in other programs, some additional constraints ensure that companies do not circumvent the regulations (see 40 CFR 89, Subpart J). EPA seeks comment on the necessity of such a provision.

I. Certification

As discussed previously, EPA expects technology to be shared between land-based engines and marine engines. EPA expects some engine manufacturers to produce engines of the same basic design for sale in both areas. Specifically, Category 1 marine engines are expected to share the technology developed for land-based nonroad engines, and Category 2 engines are expected to share technology developed for locomotive engines. To account for this product overlap, EPA is proposing to base certification data and administration requirements for Category 1 on the existing program for land-based nonroad engines, and for Category 2 marine engines on the existing program for locomotive engines.[41,42] Specific certification provisions are discussed more fully in the following sections.

1. Engine Family Definition

EPA is proposing that engine grouping for the purpose of certification be accomplished through the application of an "engine family" definition. Engines expected to have similar emission characteristics throughout the useful life are proposed to be classified in the same engine family. Separate engine family classification is also required for each marine engine category (i.e., Categories 1, 2, and 3 will be in separate engine families).

EPA is proposing specific parameters to define engine family for each category of marine engine. To provide for administrative flexibility in the proposal, the Administrator will have the authority to separate engines normally grouped together or to combine engines normally grouped separately based upon a manufacturer’s request substantiated with an evaluation of emission characteristics over the engine’s useful life.

For Category 1, EPA is proposing to use the engine family definition for land-based nonroad engines with the addition of the fuel system type and fuel injection control used (mechanical versus electrical).[43] For Category 2, EPA is proposing to use the engine family definition for locomotive engines.[44]

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[41] See 40 CFR 89 Subpart B for the provisions of the land-based nonroad engine program.

[42] See 40 CFR 92 Subpart C for the provisions of the locomotive program.

[43] See 40 CFR 89.116 for the engine family definition used for land-based nonroad engines.

[44] See 40 CFR 92.204 for the engine family definition used for locomotives.

These definitions are proposed to provide consistency between land-based and marine engines of the same basic type. The fuel system type and control type were added to the land-based nonroad engine family definition to reduce the variability of emissions within an engine family. This change will aid manufacturers in selecting the "worst-case" engine for emission testing. It will lessen the chance of noncompliance in use by ensuring that the highest emitting engine is tested during certification.

The engine family definition is fundamental to the certification process and to a large degree determines the amount of testing required for certification. As proposed, manufacturers would be required to estimate the rate of deterioration for each engine family (see the discussion of deterioration factors in Section V.G.3. for further details). Compliance with the emission standard will also be demonstrated for each engine family based upon required testing and the application of the deterioration factor. Separate certificates of conformity would be required for each engine family.

2. Emission Data Engine Selection

EPA is proposing that manufacturers select the highest emitting engine (i.e., "worst-case" engine) in a family for certification testing. In making that determination, the manufacturer shall use good engineering judgement (considering, for example, all engine configurations and power ratings within the engine family and the range of installation options allowed). By requiring the worst-case engine to be tested, EPA is assured that all engines within the engine family are complying with emission standards for the least cost in test engines run. If manufacturers feel that the engine family is grouped too broadly or that the worst-case emission data engine would underestimate the emission credits available under the ABT provisions, they may request the separation of the dissimilar calibrations (based on an evaluation of emission characteristics over the engine’s useful life) into separate engine families.

J. SEA, Production Line Testing

One of the challenges of serial engine production is ensuring that each engine produced has the same emission characteristics as the original certification engine. The more traditional approach used for ensuring that the engines are produced as designed is called Selective Enforcement Auditing (SEA). In the SEA program, EPA audits the emissions of new production engines by requiring manufacturers to test engines pulled off the production line on short notice. This spot checking approach relies largely on a deterrence strategy. Manufacturers prefer to design their engines and production processes and take other steps necessary to make sure their engines are produced as designed in order to avoid the penalties associated with failing SEA tests.

However, EPA does not believe that an SEA-type approach is practical for the marine diesel engine industry, primarily because of the low production volumes. The small production volumes mean that on any given day that EPA would choose to do an

SEA there may be no marine engines being produced, or there may not be enough to provide a representative sample of production.

Therefore, to ensure compliance of production engines, EPA is proposing an alternative approach, called Production Line Testing (PLT). The general object of a PLT program is the same as an SEA-based program, which is to enable manufacturers and EPA to determine, with reasonable certainty, whether certification designs have been translated into production engines that meet applicable standards (or FELs) at the time of production, before excess emissions are generated in use. The main difference between the two approaches is that PLT is performed on a regular basis during the year by the engine manufacturer according to criteria set by the Agency, while SEA is performed through periodic unannounced spot checks by EPA.

Under the proposed marine diesel engine PLT, a manufacturer would select engines from its production line for confirmatory testing. In general, one percent of a manufacturer's total projected annual U.S. marine diesel engine sales (propulsion and auxiliary) for each category would be required to be tested each year. EPA believes that a one percent sampling rate is appropriate for the marine diesel engine industry because of its low production volumes, and that a higher sampling rate would be unduly burdensome for this industry. EPA is not proposing a minimum number of tests for Category 1 engines and is proposing that if a manufacturer sells fewer than 100 units in the United States in a given year, it would not be required to do any PLT testing for its Category 1 engines that year. EPA requests comment on whether it would be more appropriate, in light of its proposed one percent sampling rate, to adopt a production trigger for Category 1 PLT testing of 50 engines per year, rather than 100 engines per year as proposed. EPA also requests comment on an approach whereby a manufacturer's cumulative production over time would be used to determine when PLT testing would be required for these Category 1 manufacturers. Under such an approach a test would be required under the PLT program when a manufacturer's cumulative Category 1 production over more than one model year reached 100 units. For Category 2 engines, EPA is proposing a minimum of one PLT test per year. Thus, for manufacturers with sales of less than 100 Category 2 engines a year, one test would be required. For purposes of calculating the number of tests required, EPA is proposing that Category 1 and Category 2 annual engine sales be considered separately.

EPA proposes that the choice of the engines to be tested pursuant to this program will be left to the manufacturer, but should be a random sample that is representative of annual production. EPA reserves the right to reject any engines selected by the manufacturers if it determines that such engines are not representative of actual production. Engines selected should cover the broadest range of production possible, and from year to year should be varied to cover all engine families if possible. Tests should also be distributed evenly throughout the model year, to the extent possible.

EPA proposes that emission testing of the PLT engines be conducted in accordance with the applicable federal testing procedures, and compliance with the proposed NTE provisions must be demonstrated as part of PLT testing. The results would be reported to EPA in periodic reports that would summarize emissions results, test procedures, and events such as the date, time, and location of each test. These reports will allow EPA to monitor continually the PLT data. If no testing is performed during the period, no report would be required. EPA is proposing that reports be submitted each quarter. EPA requests comment on whether quarterly reporting is too frequent, given the low production volumes of these engines, and whether a semester or trimester approach is more appropriate.

Under this testing scheme, if an engine fails a production line test, the manufacturer would test two additional engines out of either the next two days' production or the next fifteen engines produced in that engine family in accordance with the applicable federal testing procedures. EPA is proposing the dual approach to testing additional engines to account for variations in production volumes. If production volumes are high, then EPA believes that the two-day provision will allow for the orderly selection of additional test engines. Likewise, if production volumes are low, then the provision allowing the engines to be selected from the next fifteen produced will allow for orderly selection. When the average of the three test results, for any pollutant, are greater than the applicable standard or FEL for any pollutant, the manufacturer fails the PLT for that engine family. Such failures must be reported to EPA within two working days of the determination of a failure. It should be noted that, as proposed, compliance with the standards would be required of every covered engine. Thus, every engine that failed a PLT test would be considered in noncompliance with the standards and must be brought into compliance. EPA's proposal to use the average of three tests to determine compliance with the PLT program is intended only as a tool to decide when it is appropriate to suspend or revoke the certificate of conformity for that engine family, and is not meant to imply that not all engines have to comply with the standards.

In the proposed PLT program, the Administrator could suspend or revoke the manufacturer's certificate of conformity in whole or in part fifteen days after an EPA noncompliance determination for an engine family that fails the PLT, or if the engine manufacturer's submittal reveals that the PLT tests were not performed in accordance with the applicable testing procedure. During the fifteen day period following a determination of noncompliance, EPA would coordinate with the manufacturer to facilitate the approval of the required production line remedy in order to eliminate the need to halt production, to the greatest extent possible. The manufacturer must then address (i.e., bring into compliance, remove from service, etc.) the engines produced prior to the suspension or revocation of the certificate of conformity. EPA could reinstate the certificate of conformity subsequent to a suspension, or reissue one subsequent to a revocation, after the manufacturer demonstrates (through its PLT program) that improvements, modifications, or replacement have brought the engine family into compliance. The proposed regulations include hearing provisions that provide a mechanism to resolve disputes between EPA and manufacturers regarding a suspension or revocation decision based on noncompliance with the PLT. It is important to point out that the Agency would retain the legal authority to inspect and test engines should problems arise in the PLT program. It is also important to note that the definition of "failure" of the PLT is limited to the PLT program, and does not define failure or noncompliance for other purposes. It is based in part on the severity of the result of a failure (suspension or revocation of a certificate) and is not meant to limit in any way the overall obligation of the manufacturer to produce engines that meet the standard.

EPA recognizes the need to develop a PLT scheme that does not impose an unreasonable burden on the manufacturers. Therefore, consistent with the requirement that testing be required on one percent of total marine diesel engine production for each category, EPA is proposing that no PLT be required for manufacturers whose Category 1 marine diesel engines sales are less than 100 per year. This is because companies with such low sales are unlikely to have in-house testing facilities, and requiring such companies to send an engine to an independent test facility for PLT purposes may be too burdensome. EPA seeks comment on whether to extend this exemption to companies with fewer than 500 employees across all operations. It should be noted that companies that are exempt from the PLT program are not exempt from the other certification and compliance provisions described in this proposal. Engines exempt from the PLT program will still be required to meet the emission limits as produced and in use, and EPA reserves the right to conduct an SEA on any diesel engine manufacturer. In addition, EPA is not proposing to extend this flexibility provision to the Category 2 marine diesel engine PLT program, since those engines are typically produced in very small volumes.

Finally, while EPA believes that it has developed a PLT program that takes into account the circumstances of this industry, it also understands that alternative plans may be developed that better account for the individual needs of a manufacturer. Thus, provisions are proposed to allow a manufacturer to submit an alternative plan for a PLT program, subject to approval of the Administrator. A manufacturer's petition to use an alternative plan should address the need for the alternative, and should include justifications for the number and representativeness of engines tested, as well as having specific provisions regarding what constitutes a PLT failure for an engine family.

The Agency requests comment on all aspects of this proposed PLT program. Specifically, EPA requests comment on whether it should select the individual engines to be tested, or whether this should be done by the manufacturer, subject to EPA approval.

K. Miscellaneous Compliance Issues

EPA is proposing to extend the general compliance provisions for land-based nonroad engines to Category 1 and Category 2 marine diesel engines. These include the tampering, defeat device, imported engines and vessels, and general prohibition provisions. EPA seeks comment on extending these provisions to marine diesel engines, and on any modifications that should be made to these provisions to accommodate special features of these engines.

L. Averaging, Banking, and Trading Program

Along with the proposed standards, EPA is proposing a marine averaging, banking, and trading (ABT) program. An ABT program allows the Agency to propose and finalize a more stringent set of marine diesel engine emission standards than might otherwise be appropriate under section 213 of the Clean Air Act. ABT reduces the cost and improves the technological feasibility of achieving the standards, helping to ensure the attainment of the proposed standards earlier than would otherwise be possible. Manufacturers gain flexibility in product planning and the opportunity for a more cost-effective introduction of product lines meeting a new standard. ABT also creates an incentive for the early introduction of new technology, which allows certain engine families to act as trail blazers for new technology. This can help provide valuable information to manufacturers on the technology before manufacturers need apply the technology throughout their product line. This early introduction of clean technology improves the feasibility of achieving the standards and can provide valuable information for use in other regulatory programs that may benefit from similar technologies. EPA views the effect of the ABT program itself as environmentally neutral because the use of credits by some engines is offset by the generation of credits by other engines. However, when coupled with the new standards, the ABT program would be environmentally beneficial because it would allow the new standards to be implemented earlier than would otherwise be appropriate under that Act. In addition, to the extent that any credits are not used, then there is an additional environmental benefit.

The voluntary ABT program allows the certification of one or more engine families within a given manufacturer's product line at emission levels above the applicable emission standards, provided that the increased emissions are offset by one or more families certified below the emission standards. The average of all emissions for a particular manufacturer's production (weighted by sales-weighted average power, production volume and useful life) must be at or below the level of the applicable emission standards. In addition to the averaging program just described, the proposed ABT program contains a banking and trading provision, which allows a manufacturer to generate emission credits and bank them for future use in its own averaging program or sell them to another entity. Compliance is determined on a total mass emissions basis to account for differences in production volume, power and useful life among engine families.

The ABT program EPA is proposing for marine diesel engines over 37 kW is based on the corresponding ABT programs recently adopted for land-based nonroad engines (63 FR 56967, October 23, 1998) and locomotives (63 FR 18978, April 16, 1998), which roughly correspond to the proposed Categories 1 and 2, respectively. When a manufacturer chooses to participate in the ABT program, it would be required to certify each participating engine family to a family emission limit (FEL) determined by the manufacturer during certification testing. A separate FEL would need to be determined for each pollutant the manufacturer is including in the ABT program. EPA is proposing that the ABT program be limited to HC+NOx and PM emissions. Thus, only two different FELs could be generated for a given engine family.

Consistent with the recently finalized land-based nonroad engine program, marine engine credits are proposed to be calculated based on the difference between the applicable standard(s) and FEL(s). However, credit calculation for marine engines is somewhat different than that for land-based nonroad engines, in that a load factor is inserted in the equation. This term is necessary because, contrary to land-based nonroad case, not all marine engines are expected to operate at the same load. EPA seeks comment on the credit calculation equation, which is as follows:

Emission credits = (Std - FEL) X (UL) X (Production) X (AvgPR) X (10^{-6}) X (LF)

Where:

- Std = the applicable cycle-weighted marine engine THC+NOx and/or PM emission standard in grams per kilowatt-hour.
- (ii) FEL = the family emission limit for the engine family in grams per kilowatt-hour. (The FEL may not exceed the limit established in §94.304(m) for each pollutant.)
- UL = the useful life in hours.
- Production = the number of engines participating in the averaging, banking, and trading program within the given engine family during the calendar year (or the number of engines in the subset of the engine family for which credits are being calculated). Quarterly production projections are used for initial certification. Actual applicable production/sales volumes are used for end-of-year compliance determination.
- AvgPR = average power rating of all of the configurations within an engine family, calculated on a sales-weighted basis, in kilowatts.
- LF = the load factor, dependent on whether the engine is intended for propulsion or auxiliary applications, as follows:
  A. 0.69 for propulsion engines
  B. 0.51 for auxiliary engines.

Consistent with EPA's recently finalized land-based nonroad diesel engine rule, and because of the inherent trade-off between NOx and PM emissions in diesel engines, EPA is proposing to adopt for marine diesel engines the provision in the land-based nonroad ABT program prohibiting the generation of credits for one pollutant and the simultaneous use of credits for the other pollutant within the same engine family. In other words, a manufacturer would not be allowed to simultaneously generate HC+NOx credits and use PM credits on the same engine family, and vice versa. EPA requests comment on whether an engine should be allowed to generate credits on one pollutant while using credits on another, and whether allowing such an additional flexibility would necessitate a reconsideration of the stringency of the emission limits.

EPA is proposing FEL upper limits in the same manner as those in the comparable land-based ABT programs to ensure that the emissions from any given family certified under this ABT program not be significantly higher than the applicable emission standards. In general, these FEL upper limits correspond to the existing previous tier of standards for the various classes. In other words, the FEL upper limits are generally the Tier 1 standards for engines certifying according to the ABT provisions relative to the Tier 2 standards, and the Tier 2 standards for engines certifying according to the ABT provisions relative to the Tier 3 standards. Since EPA is not including any Tier 1 standards for marine engines in this proposal, it is proposing to use the land-based Tier 1 standards as FEL upper limits for the proposed Tier 2 marine engine standards. When the ABT provisions for land-based nonroad engines were recently revised there were no Tier 1 standards in place for some land-based categories and pollutants. These cases correspond to some Category 1 marine engines. In those cases EPA chose FEL upper limits based on typical in-use emission levels of precontrol engines, or existing California Air Resources Board emission standards. For a more complete discussion of the rationale for the Tier 2 FEL upper limits for Category 1 engines the reader is directed to the recent final rule concerning land-based nonroad engine emission standards. As an alternative to using the Tier 1 land-based emission standards as FEL upper limits under the proposed Tier 2 standards, EPA is requesting comment on whether it should consider using the MARPOL Annex VI NOx standard as the appropriate NOx FEL upper limit. Under this approach EPA would continue to use the land-based Tier 1 PM standard as the Tier 2 FEL upper limit. As part of this approach EPA would have to accommodate the fact that the MARPOL Annex VI standard is for NOx only and the proposed Tier 2 standards are HC+NOx. EPA requests comment under this approach as to how best to deal with this inconsistency.

Consistent with the land-based ABT programs from which this proposed program is derived, EPA is proposing that ABT credits generated under this program have an infinite life, with no discounting applied. Also consistent with the recently finalized land-based nonroad diesel rule, EPA is proposing that credits generated on land-based engines not be allowed to be used for demonstrating compliance for marine diesel engines. EPA is concerned that manufacturers who produce engines used in both marine and land-based applications could effectively trade out of the marine portion of the program, thereby potentially obtaining a competitive advantage over small marinizers who sell only marine engines. For similar reasons, EPA is proposing that credit exchanges not be permitted between Categories 1 and 2 engines. EPA seeks comment on the need for these restrictions and on the degree to which imposing them may create barriers to low-cost emission reductions.

EPA is also proposing that credits generated relative to the Tier 2 standards not be allowed to be used toward Tier 3 compliance for either Category 1 or Category 2 engines based on concerns about the possibility of using such credits to "trade out" of compliance with the Tier 3 standards.

EPA is proposing that the ABT program begin with the implementation of the Tier 2 standards, with no option for the early generation of credits. While the Agency believes that, on a total sales average basis, the Tier 2 standards as proposed will result in significant emission reductions from uncontrolled levels, it is aware of some engine configurations whose emissions are currently at or near the levels of the Tier 2 standards.

EPA is concerned that the emissions from such engine families could be reduced below the proposed Tier 2 standards without much effort and that easy credits could be generated if early banking were allowed. Such credits could then be used to significantly delay implementation of the Tier 2 standards for other engine families. EPA requests comment on whether it should consider an early credit banking option and what types of restrictions it should place on such early credits in order to address this concern. Commenters are requested to consider, among other options, restrictions such as early credits being calculated relative to levels more stringent than the Tier 2 standards, discounting of early credits (possibly only if above a set threshold level), and limited credit life for early credits.

In the recent rule cited above which set emission standards for land-based nonroad diesel engines, EPA also set emission standards for marine diesel engines below 37 kW. These engines were also included in the land-based ABT program in that rule, with some restrictions. EPA is not proposing any changes to the way under 37 kW marine diesel engines are treated in this ABT program. EPA is not proposing to integrate the ABT program in that rule for under 37 kW marine engines with this proposed program. Thus, EPA is proposing that no trading be allowed for engines above and below 37 kW. EPA requests comment on whether it should allow trading between engine families above and below 37 kW. Comments in favor of removing this proposed restriction should address that fact that the stringency of the standards for marine diesel engines below 37 kW was determined in the absence of this ABT flexibility. Comments should address whether allowing trading between engine families above and below 37 kW would appropriately require EPA to reexamine the stringency of the standards for engines under 37 kW.

EPA is proposing not to allow the exchange of credits between Category 1 marine engine families and land-based nonroad engine families. This restriction is proposed for the same reason that EPA is proposing to restrict credit exchanges between engine families above and below 37 kW (i.e., that the stringency of the land-based standards was determined in the absence of the availability of credit exchange between marine and land-based engines). In addition, there are differences in the way that marine and land-based credits are calculated that are implicit in the calculation and that make the credits somewhat incompatible. The first is that the difference in test duty cycles means there is an implicit difference in load factor between the two. The second is that there are provisions in this proposal for varying useful lives, which are not included in the land-based nonroad regulations. In addition, as discussed above, the actual credit calculation equations for the two programs are different. EPA requests comment on whether it should allow credit exchanges between marine and land-based nonroad engine families and, if so, whether credits traded from one program would need to be adjusted to account for the different credit calculation equations. EPA also seeks comment on whether it would be necessary to reconsider the stringency of the land-based nonroad emission limits were such cross-program trading allowed.[45]

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[45]It may be necessary to reconsider the stringency of the land-based nonroad engine emission standards because those limits were set based on an ABT program that is

EPA is also proposing to prohibit all trading between Category 2 engines and locomotive engines because locomotive credits are calculated based on expected remaining service life (which could be many useful life periods, due to the inclusion of the remanufacturing provisions for locomotives), whereas Category 2 marine engine credits are only calculated on a single useful life basis.

As discussed in the section on the recreational engine exemption earlier in this preamble, EPA is proposing to allow the use of certified engines in recreational applications. This allowance raises an issue with respect to credit generation in the ABT program. Engines used in recreational applications tend to have significantly lower usage rates than engines used in commercial applications. EPA is concerned that if an engine is certified as a credit generating configuration then it could, if used in a recreational application, generate credits on paper that will not have corresponding actual emission reductions in use. EPA requests comment on the likely frequency of certified engines being used in recreational applications. EPA also requests comment on whether it should take steps to prevent such "false" credits from being generated, such as by not allowing certified engines used in recreational applications from participating in the ABT program, or by prorating ABT credits according to expected usage rates.

Participation in the proposed marine diesel ABT program would be voluntary. For those manufacturers that choose to utilize the program, compliance for participating engine families would be evaluated in two ways. First, compliance of individual engine families with their FELs would be determined and enforced in the same manner as compliance with the emission standards in the absence of an averaging, banking and trading program. Each engine family must certify to the FEL (or FELs, as applicable), and the FEL would be treated as the emission limit for certification, production-line and in-use testing (as well as for any other testing done for other enforcement purposes) for each engine in the family. Second, the final number of credits available to the manufacturer at the end of a model year after considering the manufacturer's use of credits from averaging, banking and trading must be greater than or equal to zero.

When credits are generated and traded in the same model year, EPA proposes to make both buyers and sellers of credits potentially liable for any credit shortfalls, except in cases where fraud is involved. This provision is consistent with other mobile source ABT programs. The marine diesel engine certificates of both parties involved in the violating trading transaction could be voided *ab initio* (*i.e.* back to date of issue) if the engine family or families exceed emission standards as a result of a credit shortfall. Where cases involve a manufacturer being defrauded into purchasing non-existent credits, that manufacturer would only be expected to make up the credit shortfall that resulted from the lack of real credits.

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confined to land-based engines. Extending the universe of credits to include those generated by marine engines could increase the credits available to the land-based program, thus reducing the overall stringency of that program.

The integrity of the proposed marine diesel averaging, banking and trading program depends on accurate recordkeeping and reporting by manufacturers, and effective tracking and auditing by EPA. Failure of a manufacturer to maintain the required records would result in the certificates for the affected engine family or families being voided retroactively. Violations of reporting requirements could result in a manufacturer being subject to civil penalties as authorized by sections 213 and 205 of the Clean Air Act. EPA proposes to allow positive reporting errors (i.e., those errors that result in an underestimation of the manufacturer's positive credit balance) to be corrected provided that the errors are identified within 180 days of EPA's receipt of the manufacturer's annual report.

EPA requests comment on all aspects of the proposed ABT program. Specifically, the Agency requests comment on the various restrictions (averaging sets, etc.) proposed for the program and the lack of an early credit banking program, and the time limit for correcting reporting errors.

M. Special Provisions

In general, EPA sets engine emission standards that take full effect at a set point in time, concurrently precluding the installation of engines not certified to the new standards in vehicles or equipment. The rigidity of this approach is lessened to some extent through averaging, banking, and trading programs, which allow engine manufacturers to produce engines that exceed the emission limits as long as the added emissions can be offset by engines that emit below the required levels. While this approach generally works well, additional flexibility provisions to help relieve compliance burdens may be needed in special cases. Consequently, EPA is proposing the following set of flexibility provisions. EPA seeks comment on all aspects of these flexibility provisions.

1. Post Manufacturer Marinizers Provisions

Category 1 and Category 2 marine diesel engines are produced using one of three basic manufacturing methods. In the first, least common, method, marine engines are designed and built exclusively for marine applications. This is typically the case for very large Category 3 engines as well as some smaller engines that are produced for special niche markets. In the second, more common, method, an engine manufacturer produces a marine diesel engine using a land-based nonroad or highway engine that was built by that same manufacturer. In the third method, an unrelated company, referred to as a "post-manufacture marinizer" produces a marine diesel engine by purchasing a completed or partially completed land-based nonroad or highway engine from an engine manufacturer and modifying it for use in the marine environment according to that manufacturer’s own processes. Post-manufacturer marinizers (PMM) tend to be small companies, and their output is often designed for niche markets. PMMs often have only limited resources for engine certification, and several have indicated to EPA that burdensome certification requirements would put them out of business.

To address the concerns of these companies, EPA is proposing several provisions that are intended to streamline the certification process for PMMs.

a) Application of Flexibility Provisions

The following flexibility provisions will be available only to PMMs. EPA has previously defined the term "post-manufacture marinizer" in 40 CFR 89.2 as "a person who produces a marine diesel engine by substantially modifying a certified or uncertified complete or partially complete engine; and is not controlled by the manufacturer of the base engine or by an entity that also controls the manufacturer of the base engine." That definition goes on to clarify that "substantially modify means changing an engine in a way that could change engine emission characteristics."

EPA has become aware that the above definition may be too narrow. It implies that only those persons who substantially modify an engine will be considered PMM; those who do not modify the engine in ways that would change the engine's emission characteristics (i.e, the modifications are not "substantial") would not trigger the PMM designation. This was not meant to be the case. EPA intended that a person who modifies in any way an engine certified to a previous tier or who modifies in any way an uncertified engine would be considered a PMM and would have to recertify the engine to the marine emission limits in place at the time the engine is marinized. Therefore, EPA is proposing to revise the definition of PMM, to clarify that a PMM is a person who substantially modifies a land-based engine previously certified to the same or more stringent emission limits as the currently applicable marine emission limits, or a person who modifies in any way an uncertified engine or an engine certified to a previous tier of emission limits.

This modification of the PMM definition will not affect the engine dresser exemption described in Section III.B.2 above, since one of those criteria is a requirement that the dressed engine be certified to emission limits at least as stringent as those applicable to marine diesel engines a the time the engine is dressed.

Finally, EPA intends that a vessel manufacturer that substantially modifies a certified engine or that modifies an uncertified engine or an engine certified to a previous tier of emission limits would be considered a PMM and would have to comply with the certification and compliance provisions proposed in this document. This clarification is necessary because it is not uncommon for vessel manufacturers to modify marine engines. This is often done to increase the power of an engine, to respond to the needs of a particular user. By considering such vessel manufacturers as PMM, EPA will ensure that the engine modifications do not also increase the emissions of an otherwise certified engine.

b) Broader Engine Families

EPA is proposing to allow PMMs to use a broader engine family definition. Under this provision a PMM may include any engines that have similar emission deterioration characteristics in one engine family. Thus, a PMM could conceivably group all marine engines into one marine engine family. The only restriction is that the engines are all in the same category. Separate engine families will be required for each category of marine engines.

Note that all other provisions of the proposal shall apply to this broad engine family including, but not limited to, selection and testing of an emission data engine, application of a deterioration factor (DF), and compliance with the standards.

c) Carryover Provisions

This proposal makes provision for carryover of engine data, which allows engine manufacturers to use data generated in a previous model year's certification to certify for the current year. This provision will also apply to the broader PMM engine families, with the constraint that new data will need to be generated if any model in the broad family is modified in any way that will make it the highest emitter in the family.

d) Streamlined Certification for Subsequent Years

EPA is proposing a streamlined certification process for PMMs. This process would be applicable beginning with the year after the relevant implementation dates and continuing until engine design changes cause a different engine model to be the highest emitter in the broad PMM family. Recertification would be required at that point. Under this streamlined certification process, the manufacturer would submit its annual certification application stating that there have been no changes in the design or production of the engine models that make up the engine family. If there have been changes, the PMM could still avoid a complete certification submission with test data by demonstrating that there is no change in the identity of the highest emitter or its emissions. EPA requests comment on such a streamlined certification program for PMM.

e) NTE Flexibility

As noted above, EPA is including an off-cycle emission requirement whereby engine manufacturers would be required to demonstrate that marine diesel engine emissions do not exceed a specified cap at any point in a specified zone of operation (see Section V.E.2., above). EPA expects that demonstrating compliance with the NTE will call for additional R&D and testing to measure and control emissions under any speed and load combination that can occur on a vessel. These costs are included in EPA's analysis of economic impacts, but EPA believes that the costs would be disproportionately difficult for a PMM to bear. EPA therefore requests comment on alternative approaches to address in-use emissions for these small manufacturers to ensure in-use performance while minimizing the testing burden for PMMs.

f) Additional Compliance Time

Because of the nature of their business, marinizing partially or fully completed engines manufactured by another company, the ability of PMM to certify their engines as complying with the proposed emission limits may be affected by circumstances that beyond their control. Consequently, there may be situations in which, despite its best efforts, a PMM cannot meet the implementation dates, even with the flexibility provisions described above. Such a situation may occur if an engine supplier without a major business interest in a PMM were to change or drop an engine model very late in the implementation process, or was not able to supply the PMM with an engine in sufficient time for the PMM to recertify the engine. Based on this concern, EPA is proposing to allow a one-year delay in the implementation dates for PMMs. EPA requests comment on the necessity of such a provision, whether there its application should be limited only to small companies, and on whether the one-year delay should be automatic or subject to approval by EPA.

g) Special Hardship Provision

As a relief mechanism of last resort, EPA is also proposing to extend to PMM the hardship relief provisions contained in the recently finalized land-based nonroad rule (40 CFR 89.102(f)). Under this provision, PMM can petition EPA for additional time to demonstrate compliance with the emission limits. Under this hardship relief provision, appeals must be made in writing, be submitted before the earliest date of noncompliance, be limited to firms that fit the small business criteria established by the Small Business Administration (fewer than 500 employees), include evidence that failure to comply was not the fault of the PMM (such as a supply contract broken by the engine supplier, and include evidence that the inability to seel the subject engines will have a major impact on the company's solvency. The Agency would work with the applicant to ensure that all other remedies available under the flexibility provisions are exhausted before granting additional relief, and would limit the period of relief to no more than one year. Furthermore, the Agency proposes that applications for hardship relief only be accepted during the first year after the effective date of an applicable new emission standard. To avoid the creation of a self-fulfilling prophesy, by which the very existence of this provision prompts engine manufacturers to delay engine developments, EPA expects that this provision will be used only rarely. Each granting of relief would be treated as a separate agreement, with to prior guarantee of success, and with the inclusion of measures, agreed to in writing by the PMM, for recovering the lost environmental benefit. Comment is requested on all aspects of this proposal.

2. Vessel Builder Flexibilities

As part of the land-based nonroad rule, EPA proposed a set of flexibility provisions for equipment manufacturers. These provisions were intended to give equipment manufacturers more time to comply with the requirement that they use only certified engines beginning with the implementation dates the engine standards. The additional time was necessary because the engine compartment on land-based nonroad equipment is relatively restricted, and changes to the physical characteristics of a nonroad engine could require extensive equipment redesign. However, equipment manufacturers may be unable to obtain a certified Tier 2 or Tier 3 engine before the implementation dates for those engines. The flexibility provisions were designed to give extra time for product redesign to equipment manufacturers that need it without postponing the emission benefits of the entire program.

While recognizing the importance of such a transition program for land-based nonroad equipment manufacturers, EPA is not proposing a similar proposal for marine vessels. There are three reasons for this. First, EPA has learned that the commercial vessel production process is actually a very flexible process. Commercial marine vessels are generally designed for a specific purchaser, to meet specific operational requirements. This means that a vessel purchaser will typically tell a manufacturer what kind of load the vessel is intended to carry, and what kind of engine to use. The vessel manufacturer then designs the vessel, or adapts an existing design, based on these requirements. EPA believes that this kind of design process can easily accommodate any changes to an engine that may occur as a result of the proposed program, regarding its physical dimensions or weight. Second, commercial marine vessels are not serially produced in the same way as land-based nonroad equipment. Sales volume by manufacturer is much smaller in the commercial marine industry. Therefore, marine vessel manufacturers do not need extra time to accommodate engine changes across a wide range of equipment offerings. Third, it typically takes a significant amount of time to design and build a commercial marine vessel. EPA believes that any design changes required as a result of engine changes can be accommodated in the normal vessel construction period. Nevertheless, there may be special situations in which vessel manufacturers may have difficulties producing vessels that use compliant engines. EPA seeks comment on any such circumstances, and the types of flexibility provisions that would be needed to address those concerns.

N. Application of Provisions to Marine Diesel Engines Less than 37 kW

Marine diesel engines less than 37 kW were included in the rulemaking for nonroad diesel engines and are subject to the emission control program contained in 40 CFR Part 89. That program has two tiers of emission limits, phased in from 1999 to 2000 for Tier 1 and 2004 to 2005 for Tier 2. In general, marine diesel engines less than 37 kW are subject to the same certification and compliance program as land-based nonroad diesel engines. Exceptions to this general approach include the duty cycle (E3, but with a C1 option), ABT program restrictions (land-based credits cannot be used to offset marine diesel emissions), and implementation flexibility provisions that would allow post-manufacture marinizers to phase in compliance with Tier 1 emission limits according to the schedule extended to nonroad equipment manufacturers.

EPA is aware that some companies manufacture marine diesel engines above and below the 37 kW threshold. Most of these companies are small businesses with limited ability to devote staff to managing compliance with emission control requirements. One possible administrative change that may lessen this burden would be to move the provisions for marine diesel engines rated below 37 kW currently contained in 40 CFR Part 89 to 40 CFR Part 94. Transferring the provisions for marine diesel engines rated below 37 kW in this way would ensure that engine manufacturers, vessel manufacturers, and the general public need consult only one area of the Code of Federal Regulations to identify the emission control programs applicable to all marine diesel engines.

An important goal of any such change should be to avoid changing the level of stringency of the requirements for marine diesel engines less than 37 kW. EPA therefore does not intend to change the level or timing of emission limits or other provisions that may affect the emissions from these engines.

EPA is, however, seeking comment on the extent to which the administrative portions of the certification and compliance requirements for marine diesel engines less than 37 kW should be harmonized with those proposed in this document. Commenters are encouraged to specify which provisions should be harmonized for these engines and to explain why this would be helpful. EPA believes that such harmonization would be appropriate for several reasons. First, harmonization of these provisions will ensure that engine manufacturers have only one set of administrative requirements to follow instead of two, thus simplifying the certification and approval process for both the manufacturers and EPA. Second, harmonization would formally extend the special compliance flexibility provisions of this proposal to post-manufacture marinizers that modify smaller diesel engines, including the more relaxed definition of engine family and streamlined certification renewals. Third, this would clarify the requirements for engine dressers.

VI. Category 3 Engine Provisions

A. Emission Limits

Category 3 engines are very large marine diesel engines, typically used for propulsion purposes on ocean-going vessels. Although these engines can achieve power ratings in excess of 75,000 kW, they are diesel engines and, with certain limitations, can benefit from the emission control technologies that are used on other diesel engines. Perhaps the most important of these limitations is the fuel on which they are operated, called residual fuel. This fuel is the by-product of distilling crude oil to produce lighter petroleum products such as gasoline, DM-grade diesel fuel (used in on-highway, land-based nonroad and smaller diesel marine engines), and kerosene. It possesses a high viscosity and density, which affects ignition quality, and it typically has high ash, sulfur and nitrogen content in comparison to marine distillate fuels. Furthermore, residual fuel parameters are highly variable because its content is not regulated. It is this high variability that makes it difficult to apply timing retard as a control strategy. Ship engineers will generally optimize engine timing to achieve peak pressures for each fuel blend and would not likely have the expertise or incentive to optimize for emissions.

Residual fuel can increase engine NOx emissions from 20-50% and PM from 750% to 1250% when compared to distillate fuel.[46]

In determining the appropriate emission limits for Category 3 engines, EPA considered the application of existing diesel emission technologies. These engines are, for the most part, already employing Tier 1 and Tier 2 technologies, including turbocharging, injection improvements, electronics, and more efficient cooling. Application of these technologies has already been extremely optimized, with engines being supercharged as well as turbocharged, and with two-stage seawater aftercooling to reduce engine temperatures. The application of these technologies results in very high fuel efficiency and optimal engine operation.

Because of the extensive use of Tier 2 technologies on Category 3 engines, the opportunities for emission reductions are not as extensive as they are for smaller engines. The most likely set of next-generation technologies that could potentially be applied to these engines include EGR, SCR, and water injection. However, as discussed in the Draft Regulatory Impact Assessment, these technologies are still under development for marine diesel engines of this size and thus the Agency does not believe it is appropriate to set emission limits that would require their use at this time. In addition, their application to Category 3 engines is complicated by the quality of the fuel used in these engines.

EPA believes it is appropriate to consider an emission limit that would rely largely on the use of injection rate shaping, with some retarded timing. By optimizing a variable fuel injection rate, a small amount of fuel can be delivered early to initiate combustion. Once combustion begins, the rest of the fuel can be injected. Through this strategy, the peak temperature in the cylinder can be reduced by reducing the amount of fuel that is mixed with air prior to the start of combustion. This premixed fuel results in a large thermal spike when it burns when compared to diffusion burning. By reducing the peak temperatures, it is more difficult for NOx to form.

EPA analysis indicates that the appropriate emission limits for Category 3 engines, that would require injection rate shaping but not extensive timing retard, are the limits that were recently adopted in MARPOL Annex VI. These NOx limits also take into account the special fuel used by these engines. Those limits are contained in Table 1, above. EPA also believes that these emission limits would be the appropriate standards under the Clean Air Act, under the current circumstances. With respect to emission reductions, while MARPOL Annex VI targeted a 30% NOx emission decrease, EPA analysis indicated that a 17% NOx decrease could be expected. However, implementation of these NOx limits will prevent further increases in NOx resulting from further developments in Category 3 engine design. Because of Category 3 engines' characteristic design and operation for minimum BSFC (see the Draft RIA), further

[46]D. Bastenhof. Exhaust Gas Emission Measurements: A Contribution to a Realistic Approach, 1995 (Air Docket A-97-50).

improvements in materials and engine design will only increase specific NOx emissions in the absence of these limits.

Because the MARPOL Annex VI NOx limits would likely be implemented independently of any Clean Air Act requirement, assuming ratification by the United States of Annex VI, EPA believes it would be unnecessary and redundant to adopt the same program under the Clean Air Act. Therefore, EPA is not proposing to adopt emission limits for Category 3 engines as part of this rule. Instead, EPA expects U.S. vessel owners to begin installing engines certified to the MARPOL Annex VI limits beginning with the effective date set in Annex VI (January 1, 2000), following the procedures otherwise applicable to that Annex. EPA requests comment on this approach, as well as the rationale behind its adoption. EPA seeks comment on how to ensure that U.S. vessel owners begin installing Category 3 engines beginning with ships constructed on or after January 1, 2000. EPA also seeks comment as to whether EPA should be required to examine implementation of the Annex domestically as part of the 2003 Feasibility Review, described in Section V.A.3., above.

EPA seeks comment on the proposed approach to Category 3 engines. EPA also seeks comment on whether EPA should consider a longer terms strategy as well and, if so, what those long-term NOx emission limits should be. Finally EPA seeks comment on the need to adopt a PM limit for these engines. MARPOL Annex VI does not set a PM limit, presumably because of the fuel variability issue and the lack of an appropriate PM test method for residual fuels (see the Draft RIA). EPA seeks comment on the desirability to go beyond the Annex VI requirement by setting a PM standard for Category 3 engines and, if so, what that PM limit should be and how it shall be tested.

Category 3 engines can switch between fuels, and, as stated above, residual fuel can increase NOx emissions by 20%-50% and PM emissions by 1000% (±250%) compared to marine distillate fuel. Foreign vessels with Category 3 engines currently account for 45% of the NOx emissions from Category 3 engines (see the Draft Regulatory Impact Assessment). One mechanism to reduce NOx emissions from these engines would be restricting the use of residual fuel in or near port regions, perhaps utilizing remote CO_2, SOx, and PM sensing technologies to non-intrusively discriminate the fuel burned by a ship. If such a technology can be demonstrated, enforcement could become as straightforward as determining automobile speed on a highway. EPA seeks comment on whether ports and states could effectively employ such a strategy, for example as a condition on use of ports. Comments provided on this question will assist EPA in assessing the extent to which such a locally-imposed emission control strategy would be practical. These comments, in turn, will also help EPA determine whether it would be useful to issue guidance on how to establish such programs, both for California's South Coast ports and ports located in other areas of the country.

B. Category 1 and 2 Engines Aboard Vessels Engaged in Foreign Trade

EPA proposes an additional provision for Category 1 and 2 engines that are installed on U.S.-flagged vessels engaged in foreign trade that meet the criteria described below. This provision will allow these engines to be certified to the MARPOL Annex VI NOx curve instead of the EPA proposed limits provided certain conditions are met. This provision would go into effect at the same time as the implementation of the proposed domestic emission requirements for these engines. In other words, waivers would not be needed until 2004 for engines with a per cylinder displacement below 2.5 liters and until 2006 for engines with a per cylinder displacement at or above 2.5 liters but below 20 liters. Prior to these dates, it is assumed that engines installed on these vessels will be compliant with the MARPOL NOx limits.

This special provision is intended to address the different circumstances in which these engines will be used, rather than any differences in their operation. Specifically, Category 1 and Category 2 engines installed on foreign trade vessels are typically used for auxiliary purposes. These engines are often essential for the smooth functioning of the vessel, since they are used to generate electricity for navigational equipment (radar, gyrocompass, and telecommunications), maneuvering equipment (steering gear, bow thrusters), and crew services (lighting in the engine room, cooking in the galley). If these engines were to fail, a ship would be stranded and would most likely require a tow into port. Repairing engines to EPA requirements may be difficult in a foreign port because of availability of replacement parts. This may cause a ship owner to incur significant downtime costs to have the replacement part or a new engine delivered to a foreign port. Alternatively the ship owner may have to buy a noncomplying engine while overseas, only to replace it when the vessel returns to the United States. Allowing Category 1 and Category 2 engines to meet the MARPOL Annex VI limits instead of the EPA's requirements will reduce if not eliminate any difficulties associated with the maintenance and repair of these engines while at sea, since vessels worldwide are expected to comply with those limits beginning in 2000.

EPA believes that this special provision for Category 1 and Category 2 engines will have minimal impact on U.S. air quality if it is limited to those vessels that engage in foreign trade. EPA proposes to define a U.S.-flagged vessel engaged in foreign trade as one that has solely a registry endorsement pursuant to Coast Guard regulations at 46 CFR 67.17. Vessels with multiple endorsements (e.g., foreign and coastwise) will need to demonstrate to the Administrator's satisfaction that the vessel will spend less than 25% of its operating time within 320 nautical kilometers (200 nautical miles) of U.S. territory. This determination would need to be made during the ship's construction, based on the business plans of the ship owner. EPA does not believe application for this determination will be burdensome because the vessel owner will have built the ship with a specific trade in mind.

To ensure that only the appropriate vessels use this provision, EPA proposes that Category 1 and 2 engines be labeled to indicate that they have been certified only to the MARPOL Annex VI NOx curve limits, and that they are not intended for use on domestic vessels. In addition, EPA proposes that any vessel owner who seeks this exemption obtain a waiver from EPA. Such a waiver would be issued upon satisfactory demonstration that the vessel will be used for foreign trade. EPA proposes that a vessel will be considered to be used for foreign trade if it spends less than 25 percent of its operating time within 200 nautical miles of the United States, and it does not operate solely between the United States, Canada, Mexico, Bermuda, or the Bahamas. Without this additional limit, EPA is concerned that ships whose engines do, in fact, have a significant impact on U.S. air quality would be exempt from the proposed domestic program. Also, because they operate in closer proximity to the United States these vessels are unlikely to experience problems with maintaining engines certified to EPA standards.

EPA seeks comment on whether this special provision for Category 1 and Category 2 engines installed on U.S.-flagged foreign trade vessels is necessary. EPA also requests comment on how best to define the group of vessels that should benefit from the provision while ensuring that those vessels operating in the United States meet the emission requirements proposed in this document. EPA requests comment on whether ships that operate solely between the United States, Mexico, the Bahamas, and Canada should be able to benefit from this provision.

VI. Technological Feasibility

The emissions standards proposed in this action would apply to a large variety of marine diesel engine sizes and applications. Section 213(a)(3) of the Clean Air Act calls for EPA to establish standards that provide for the "greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the engines or vehicles to which such standards apply, giving appropriate consideration to the cost of applying such technology within the period of time available to manufacturers and to noise, energy, and safety factors associated with the application of such technology."

This section describes EPA's understanding of the range of technologies that will be available to manufacturers to comply with the proposed standards for Category 1 and 2 marine diesel engines and the technological approach anticipated for Category 3 marine engines. EPA believes that the technology discussed below will be sufficient for both the proposed standards and the NTE requirements. The costs associated with these technologies will be discussed in Section VII. EPA has concluded, as described in the Draft RIA, that the proposed standards will have no significant negative effect on noise, energy, or safety. The technological feasibility of the proposed standards is discussed below for each category.

A. Category 1 Engines

EPA believes that the emission reduction strategies that are expected to be used on land-based nonroad diesel engines to meet the nonroad Tier 2 and Tier 3 standards can also be applied to Category 1 marine diesel engines. This is because marine diesel engines are generally derivatives of land-based nonroad and highway engines. Marine engine manufacturers and marinizers make modifications to the engine to make it ready for use in a vessel. These modifications can range from basic engine mounting and cooling changes to a restructuring of the power assembly and fuel management system. The Draft RIA discusses this process in more detail.

1. Development of Implementation Schedule

For Category 1 engines with specific displacements below 2.5 liters per cylinder, the proposed implementation dates for Tier 2 essentially represent a four year lead time beyond the scheduled implementation date of the MARPOL Annex VI NOx standard. Another four years of lead time is proposed for Tier 3. Having a single implementation date for several subcategories has an advantage for marine engines because it removes concerns associated with engine families that fall into several subcategories. This is important since marine engines may not fall into the same categories as their land-based nonroad counterparts. In some cases, using the same staggered approach for marine as for land-based nonroad engines could require the marine version to be certified before the land-based version of an engine. However, it is EPA's intent that marine engine designs have the benefit of being able to make use of the emission controls developed for land-based nonroad engines.

The proposed implementation schedule allows up to a three-year delay in standards for Category 1 marine engines relative to the implementation dates of the land-based nonroad standards. This should make this proposed regulatory scheme more cost-effective by allowing time for the carryover of technology from land-based nonroad to marine engines.

For engines with specific displacements greater than or equal to 2.5 liters per cylinder, EPA proposes an additional two years of lead time. This additional lead time would make the implementation date for the proposed marine Tier 2 standards consistent with the land-based nonroad Tier 2 implementation date for these engines. Therefore, the marine engines would be able to use technology developed for land-based applications. In addition, there are currently no Tier 3 standards for land-based nonroad engines of this size; therefore, the extra lead time may be necessary for the larger Category 1 marine engines to achieve Tier 3 levels. EPA requests comment on the proposed implementation dates.

2. Development of Numerical Standards

Marine diesel engines are typically derived from or use the same technology as land-based nonroad diesel engines and should therefore be able to effectively use the same emission control strategies. In fact, marine engines can make use of the water they operate in as a cooling medium, which can help them reduce charge air intake temperatures more easily than land-based nonroad engines. By cooling the intake charge, formation of NOx emissions can be reduced. Also, as discussed in Chapter 3 of the Draft

RIA, data on five marine engines show that emissions measured on the proposed ISO E3 marine duty cycle are roughly equivalent to those measured on the land-based nonroad ISO C1 duty cycle. Finally, several demonstration marine diesel engines have been in service for a couple years in California with emission levels that are very close to meeting the standards proposed in this document. These demonstration engines are all using established technology that EPA anticipates will be used to comply with this proposed rule. The Draft RIA provides more detail on the emissions levels achieved and the technology applied to these engines.

Because of the lead time needed to transfer land-based technology to the marine environment, EPA believes that it is reasonable to propose near-term standards that are somewhat less stringent compared to land-based nonroad in the Tier 2 time frame. EPA believes that more stringent Tier 3 standards are feasible in the long term especially given the technology being developed for land-based nonroad engines and the long lead time. Proposing a slightly less stringent numerical NOx emissions limit for Tier 2 marine than for Tier 2 land-based nonroad engines should allow marine engine manufacturers the flexibility to focus on Tier 3 technology and still reduce emissions in the interim without spending excessive resources on Tier 2.

3. Technological Approaches

EPA anticipates that the proposed standards for marine engines will be met primarily with technology that will be applied to land-based nonroad engines to meet the proposed Tier 2 and Tier 3 emission standards. Much of this technology already has been established in highway applications and is already being used in limited land-based nonroad and marine applications. EPA's analysis of this technology is described in detail in Chapter 3 of the Draft RIA for this proposed rule and is summarized below.

By proposing multiple levels of standards that extend well into the next decade, EPA is providing engine manufacturers with substantial lead time for developing, testing, and implementing emission control technologies. This lead time and the coordination of standards with those for land-based nonroad engines allows time for a comprehensive program to integrate the most effective emission control approaches into the manufacturers' overall design goals related to durability, reliability, and fuel consumption.

Engine manufacturers have already shown some initiative in producing limited numbers of low NOx marine diesel engines. More than 80 of these engines have been placed into service in California through demonstration programs. The Draft RIA discusses, in detail, these engines and their emission results. Through the demonstration programs, EPA has been able to gain some insight into what technologies can be used to meet the proposed emission standards.

Highway engines have been the leaders in developing new emission control technology for diesel engines. Because of the similar engine designs in land-based nonroad and marine diesel engines, it is clear that much of the technological development that has led to lower emitting highway engines can be transferred or adapted for use on land-based nonroad and marine engines. Much of the improvement in emissions from these engines comes from "internal" engine changes such as variation in fuel injection variables (injection timing, injection pressure, spray pattern, rate shaping), modified piston bowl geometry for better air-fuel mixing, and improvements intended to reduce oil consumption. Introduction and ongoing improvement of electronic controls have played a vital role in facilitating many of these improvements.

Other technological developments that are expected to be used on nonroad engines will require a greater degree of development before they can be applied to marine diesel engines. Turbocharging is widely used now in marine applications, especially in larger engines, because it improves power and efficiency by compressing the intake air. Turbocharging may also be used to decrease particulate emissions in the exhaust. Today, marine engine manufacturers generally have to rematch the turbocharger to the engine characteristics of the marine version of a nonroad engine and often will add water jacketing around the turbo housing to keep surface temperatures low. Once the Tier 2 nonroad engines are available to the marine industry, matching the turbochargers for the engines will be an important step in achieving low emissions.

Aftercooling is a well established technology that can be used to reduce NOx by reducing the temperature of the charge air after it has been heated during compression. Reducing the charge air temperature directly reduces the peak cylinder temperature during combustion, which is the primary cause of NOx formation. Air-to-water and water-to-water aftercoolers are well established for land-based applications. For engines in marine vessels, there are two different types of aftercooling used: jacket-water and raw-water aftercooling. With jacket-water aftercooling, the coolant to the aftercooler is cooled through a heat exchanger by ambient water. This cooling circuit may be either the same circuit used to cool the engine or a separate circuit. By moving to a separate circuit, marine engine manufacturers would be able to achieve further reductions in the intake charge temperature. This separate circuit could result in even lower temperatures by using raw water as the coolant. This means that ambient water is pumped directly to the aftercooler. Raw-water aftercooling is currently being used widely in recreational applications. Because of the access that marine engines have to a large ambient water cooling medium, EPA anticipates that marine engine manufacturers will largely achieve the reductions in NOx emissions for this proposal through the use of aftercooling.

To meet the proposed standards, Category 1 marine diesel engine manufacturers are expected to use many of the strategies discussed above. Electronic controls offer great potential for improved control of engine parameters for better performance and lower emissions. Unit pumps or injectors would allow higher-pressure fuel injection with rate shaping to carefully time the delivery of the whole volume of injected fuel into the cylinder. Marine engine manufacturers should be able to take advantage of modifications to the routing of the intake air and the shape of the combustion chamber of nonroad engines for improved mixing of the fuel-air charge. Separate circuit jacket- and raw-water aftercooling will likely gain widespread use in turbocharged engines to increase performance and lower NOx.

To meet the proposed Tier 3 standards, EPA believes that two technologies would be especially useful. Common rail injection systems provide greater overall control of the fuel injection strategy by maintaining a constant supply of high-pressure fuel at the injectors. Also, exhaust gas recirculation is anticipated to be applied to land-based nonroad diesel engines, which will provide valuable experience in applying this control strategy to marine engines. These technologies are not anticipated to be developed for land-based nonroad engines with specific displacements greater than or equal to 2.5 liters per cylinder. However, EPA believes that the concepts can be adapted from smaller land-based nonroad and highway engines. To account for difficulties of adapting common rail fuel injection and EGR to these larger engines, EPA is proposing a higher marine Tier 3 HC+NOx standard than for engines with specific displacements less than 2.5 liters per cylinder. A more detailed treatment of the feasibility of these engines meeting the proposed standards is included in the Draft RIA.

4. Conclusions Regarding Technological Feasibility

The standards in this proposal are the most challenging that can be set in this time frame. Category 1 marine diesel engine manufacturers will need to use the available lead time to develop the necessary emission control strategies, including transfer of technology from land-based nonroad diesel engines. This development effort will require not only achieving the targeted emission levels, but also ensuring that each engine will meet all performance and emission requirements over its useful life. The proposed standards clearly represent significant reductions compared with baseline emission levels.

Emission control technology for diesel engines is in a period of rapid development in response to the range of emission standards in place and anticipated for highway and land-based nonroad engines in the years ahead. This development effort will automatically transfer to some extent to marine engines, since marine engines are often derivatives of highway and land-based nonroad engines. Regardless, this development effort will need to expand to marine diesel engines as a result of this proposal. Because the technology development for highway and land-based nonroad engines will to a large extent constitute basic research of diesel engine combustion, the results should be applicable to marine engines.

Based on information currently available, EPA believes that it is feasible for Category 1 marine diesel engine manufacturers to meet the proposed standards using combinations of technological approaches discussed above and in the Draft RIA. To the extent that the technologies described above may not yield the full degree of emission reduction anticipated, manufacturers could still rely on a modest degree of fuel injection timing retard as a strategy for complying with the proposed emission standards. As described under Economic Impacts below, injection timing retard may be associated with some decrease in fuel efficiency.

In addition, EPA believes that the flexibilities incorporated into this proposal will permit marinizers and vessel builders to respond to engine changes in an orderly way. For these industries, EPA expects that meeting these requirements will pose a significant challenge, but one that is feasible taking into consideration the availability and cost of technology, time, noise, energy, and safety.

B. Category 2 Engines

EPA believes that the emission reduction strategies that are expected to be used on locomotive diesel engines to meet the recently finalized standards can also be applied to Category 2 marine diesel engines. This is because the majority of Category 2 marine diesel engines are derivatives of locomotive engines. Similar to Category 1, marine engine manufacturers and marinizers then make modifications to the engine to make it ready for use in a vessel.

1. Development of Implementation Schedule

EPA is proposing a similar approach as proposed for Category 1 engines. Because of the marinization process, marine engine manufacturers will likely need some time to respond to changes in locomotive engine designs associated with their standards. This is why EPA is proposing that there be a one year delay between the implementation of the locomotive Tier 2 and the marine Tier 2 standards. EPA believes that a four year additional lead time is sufficient for Category 2 marine engine manufacturers to achieve the additional reductions associated with the proposed Tier 3 standards. In any case, the Tier 3 standards are proposed to be subject to a feasibility review in 2003.

2. Development of Numerical Standards

EPA proposes the marine Tier 2 emissions standards for Category 2 marine diesel engines to be the same level as the locomotive line-haul Tier 2 emissions standards. The Draft RIA compares baseline marine emissions on the E2 and E3 cycles to baseline locomotive emissions on the line-haul cycle and shows that the baseline emissions for marine are about the same or slightly lower than for locomotives. Thus, EPA believes that no change in the standards is required due to the duty cycle. Although locomotives are required to meet standards for a line-haul and a switch duty cycle, the line-haul standard was chosen for this comparison because it is more similar to the proposed marine duty cycles than the switch cycle.

EPA believes that further reductions are possible from Category 2 marine engines than are required for locomotive engines. This is why EPA is proposing Tier 3 standards for Category 2 marine engines. Technologically, marine engines do not have nearly the cooling constraints that locomotive engines have and they do not need to be designed for operation at high altitudes. In addition, under the lead time associated with the proposed Tier 3 standards, EPA believes that further emission control technology can be applied to these engines.

3. Technical Approach

Most of the emission control strategies anticipated to be used on locomotive engine to meet the locomotive Tier 2 standards are similar to those expected to be used on nonroad engines to meet the land-based nonroad Tier 2 standards. These technologies include combustion chamber modifications, better oil control, improvements in fuel injector design (i.e., rate shaping, higher pressures, nozzle geometry), electronic engine management controls, and separate circuit aftercooling. In addition, the older two-stroke engine designs are already being replaced by four-stroke engine designs. EPA believes that these technological improvements can be directly applied to Category 2 marine diesel engines. Most likely, the marine engine manufacturers will need to rematch the turbochargers and cooling circuits to respond to the new locomotive engine designs.

EPA believes that marine engines have two advantages over locomotive engines for reducing NOx. Marine engines have access to ambient water, which gives them the ability to achieve very low charge air temperatures with an aftercooler. Locomotives, on the other hand, have extreme packaging constraints, which minimize their ability to cool the charge air. Locomotive engines must also be designed to meet their standards at high altitudes while Category 2 marine diesel engine operate at or near sea level. Because marine engines do not operate at high altitude, they have less of a concern for design tradeoffs between maintaining low NOx and low smoke levels.

Similar to Category 1, EPA believes that the key technologies needed for Category 2 marine engines to meet the proposed marine Tier 3 emissions standards are common rail fuel injection and exhaust gas recirculation. These technologies are not anticipated to be developed for locomotive engines for Tier 2. However, EPA believes that the concepts can be adapted from land-based nonroad and highway engines. As an alternative strategy, manufacturers may choose to rely on injection timing retard as a way of trimming NOx emissions. However, this may be associated with a fuel efficiency penalty. To account for difficulties of adapting common rail fuel injection and EGR to these larger engines, EPA is proposing the same marine Tier 3 HC+NOx standard proposed for Category 1 engines with specific displacements greater than 2.5 liters per cylinder. This proposed standard is somewhat relaxed compared to the land-based nonroad Tier 3 standards.

4. Conclusions Regarding Technological Feasibility

Based on information currently available, EPA believes that it is feasible for Category 2 marine diesel engine manufacturers to meet the proposed standards using combinations of technological approaches discussed above and in the Draft RIA. In addition, EPA believes that the implementation schedule and the flexibilities incorporated into this proposal will permit marinizers and vessel builders to respond to engine changes in an orderly way. For these industries, EPA expects that meeting these requirements will pose a significant challenge, but one that is feasible taking into consideration technology, time, noise, energy, and safety.

C. Category 3 Engines

EPA is not proposing national standards for Category 3 marine engines. However, emissions reductions are expected to be gained through the international NOx requirements adopted in MARPOL Annex VI.

1. Rationale for Relying on MARPOL Annex VI Requirements

Because of the competitive nature of international maritime transport, ship owners and ship builders have been working for years on techniques to improve diesel engine fuel efficiency. These research efforts have been very successful, and the thermal efficiencies of new Category 3 marine diesel engines are very high, approaching 45 to 50 percent. System efficiencies (i.e., the thermal efficiency for the ship as a whole) can be as high as 85 percent, for example, because of the use of engine heat to generate steam power. The competitive nature of the shipping industry continues to provide incentives for gaining further reductions in fuel consumption since fuel is the largest variable cost associated with shipping.

Category 3 engines have two characteristics that require discussion. First, the same strategies that have been used over time to achieve these high thermal efficiencies have generally resulted in an increase in NOx emissions. Reducing NOx with the technology used today basically means calibrating the engines with a focus on emissions as well as fuel consumption. For instance, timing could be retarded to reduce NOx by reducing peak cylinder temperatures associated with the burning of fuel that is premixed with air prior to the start of combustion. Any resulting adverse impact on fuel consumption could be minimized through fuel injection strategies and charge air charging and cooling strategies. Consequently, EPA does not expect any significant increase in fuel consumption rates. Added emission control could be achieved using EGR, water in fuel emulsion, or SCR. The benefits and drawbacks of these technologies are discussed below.

Second, Category 3 engines operate on bunker fuel. This fuel is also called residual fuel because it is the fuel left in a refinery after the lighter ends have been distilled. Although some distillate may be blended into this residual fuel, the resulting bunker fuel is considerably different than the fuel burned by any other diesel engines. For instance, the viscosity is so high, that the fuel must be melted before it can flow to the engine. The warmed fuel also needs to be passed through centrifuges to remove water, sludge, and other contaminants. Sulfur levels in this fuel may be as high as 5 percent by weight. Specifications even exist for the amount of cat bottoms (worn metal and catalyst from a hydro-cracker) in the fuel. The special characteristics and handling needs of bunker fuel make the application of new emission control technologies challenging.

Because of the special fuels used by these engines and their international use, EPA is not proposing to set national emission limits for Category 3 engines beyond the MARPOL Annex VI requirements based on the types of technologies that are already used for fuel efficiency reasons on these engines today. EPA believes that this approach is reasonable given the Clean Air Act requirements that direct EPA to promulgate regulations that achieve the greatest degree of emission reduction achievable through the application of available technology giving appropriate consideration to cost, lead time, noise, energy, and safety concerns. Applicable technology for Category 3 engines is discussed below. EPA believes that the proposed limits will not only prevent future increases in NOx associated with historical design improvements, but actually reduce NOx from new engines by about 17 percent as discussed in the Draft RIA.

EPA's main focus across all of its diesel engine emission control programs is to reduce NOx and PM emissions. HC and CO limits are of less importance because the contribution of diesel engines to the inventory of these pollutants is relatively low. With regard to Category 3 engines, high PM emissions are largely a result of the fuel used in these engines, as opposed to the technical characteristics of these engines. As discussed in the Draft RIA, the use of residual fuel or residual fuel blends in these engines can lead to PM emissions that are an order of magnitude higher than when distillate fuel is used. In addition, current established PM test methods show unacceptable variability when sulfur levels exceed 0.8 weight percent sulfur, and no PM test has been developed for these engines that corrects that variability. For these reasons, EPA is not proposing a PM standard for Category 3 engines. Similarly, EPA is not proposing HC or CO standards for these engines, but requests comment on whether adding such additional standards on top of the MARPOL Annex VI NOx standard is necessary, and if so at what levels.

2. Technological Approaches

A number of technical designs and engine modifications are capable of reducing NOx emissions from compression-ignition engines and have the potential to be technologically feasible for Category 3 marine engines. These technologies include retarded injection timing, engine fine tuning, exhaust gas recirculation, water emulsified fuel, and selective catalytic reduction. Benefits and challenges associated with these technologies are discussed below and were derived from CARB Mail-Out #91-42 and information gathered by the NOx working group of the Bulk Chemical Handling Subcommittee of the IMO.

A feasible and simple means of reducing NOx from diesel engines is by retarding injection timing. This method lowers the peak combustion temperature and pressure in the cylinder, resulting in 10-30 percent lower NOx. However, the disadvantages include higher specific fuel consumption, lower power, harder startability, and higher levels of HC, CO, PM, and smoke. In addition, injection timing generally has to be tailored to fuel quality for Category 3 engines operating on residual fuel. To recover the lost fuel economy and performance or to reduce the amount of injection timing retard, additional technologies that improve fuel atomization have been employed on other mobile source engines. Fuel atomization can be improved by increasing fuel pump pressure and advance strategies, and through nozzle geometry. Another fuel injection technique for reducing NOx is rate shaping. By injecting a small amount of fuel to begin combustion before injecting the majority of the fuel, high temperatures associated with the burning of premixed fuel can be reduced.

Engine fine tuning includes modification of essential engine components and could result in a 20-40 percent reduction in NOx emissions. More specifically, engine fine tuning could include modifications in the injection system, charge air system, and combustion chamber design. Such changes on new highway engines have already achieved more than 50 percent NOx reductions.

Exhaust gas recirculation (EGR) involves recirculating some of the exhaust gas back into the intake manifold. This lowers the combustion temperature and therefore can lower NOx emissions by as much as 20-50 percent. For marine engines, the applicability of EGR is complicated by the quality of the fuel. Sulfur and soot from combustion gases can cause increased wear of piston rings, valves, and other components. Therefore, EGR is more likely to be useful for engines running on cleaner distillate fuels.

Water emulsification of the fuel is another technique that lowers maximum combustion temperature, reducing NOx 20-50 percent without an increase in fuel consumption. There are at least two ways to accomplish the emulsification during combustion: in the combustion chamber or in the fuel tank. Combining water and fuel for the first time in the chamber requires significant changes to the cylinder head to add an injector. Combining water with fuel in the tank may introduce combustion problems due to unstable emulsion. Also, this technique requires a significantly redesigned fuel handling system to overcome the potential risk of corrosion and to maintain power output. In any event, extra liquid storage availability is necessary to retain similar range.

Selective catalytic reduction (SCR) is one of the most effective, but also most complex and expensive, means of reducing NOx from large diesel engines. Emission reductions in excess of 90 percent can be achieved using SCR. In SCR systems, a reducing agent, such as ammonia, is injected into the exhaust and both are channeled through a catalyst where NOx emissions are reduced. These systems are being successfully used for large stationary source applications, which operate under constant, high-load conditions.

A number of disadvantages are apparent for the use of current technology SCR systems on ships. The SCR system is effective only over a narrow range of exhaust temperatures. The effectiveness of the system is decreased at reduced temperatures exhibited during engine operation at partial loads. Most of the engine operation near port cities is likely to be at these partial loads. This sort of a system would require an additional tank to store ammonium (or urea to form ammonia). Also, excess ammonia in the exhaust can occur during transient operation, where control of optimum ammonia injection is difficult. However, Category 3 marine engines generally operate under steady-state conditions.

3. Conclusions Regarding Technological Feasibility

Given the available emissions control technology for Category 3 engines and the fuel quality issues, EPA believes that the MARPOL Annex VI standards for NOx are appropriate and sufficient for Category 3 marine diesel engines. EPA's main concern is that the range of adjustable parameters be set so that the engine will meet the proposed standards in this range. EPA proposes to use, and seeks comment on, the MARPOL Annex VI provisions designed to prevent tampering with the engine settings in such a way as will increase emissions. EPA believes that it may be appropriate to investigate PM standards and more stringent NOx standards for Category 3 engines in the context of the MARPOL Convention in the future.

VIII. Projected Impacts

A. Environmental impacts

In Chapter 5 of the Draft Regulatory Impact Analysis, EPA provides a detailed explanation of the methodology used to determine the environmental benefits from marine diesel engines associated with this proposal. EPA requests comment on all aspects of the emissions inventory analysis. The following discussion gives a general overview of the methodology and the results.

1. Category 1 Engines

For the purposes of the inventory analysis, Category 1 was divided into recreational, commercial, and auxiliary marine diesel engines. Although no standards are proposed in this document for recreational engines, uncontrolled emissions from these engines are included in the inventory analysis. Annual emissions were then calculated using engine populations, load factors, annual hours of use, rated power, emission factors, turnover, and growth rates. The sources for and the values of these factors are provided in the Draft RIA. It should be noted that EPA has received some indication that the annual use for recreational engines may be lower than assumed in the inventory analysis and calculations (Table 5-2 of the Draft Regulatory Impact Analysis). EPA seeks comment on annual usage rates for recreational, as well as commercial and auxiliary, engines.

Table 12 presents the projected emissions inventory from Category 1 marine engines with and without the proposed standards. Table 12 also presents the anticipated effects of the MARPOL Annex VI standards on the Category 1 NOx inventory. The proposed CO standard is intended as a cap, so no benefits are claimed here.

Table 12
Category 1 Emissions Inventory (thousand short tons)

Year	HC		NOx			PM		CO
	base	control	base	MARPOL Annex VI	control	base	control	base
2000	12.1	12.1	465	464	464	14.9	14.9	73
2005	12.8	12.5	492	484	470	15.8	15.2	78
2010	13.6	12.1	521	507	420	16.8	14.1	82
2020	15.3	12.0	586	565	303	18.9	13.0	92
2030	17.3	13.4	663	640	310	21.4	13.0	105

2. Category 2 Engines

Baseline emissions inventories for Category 2 marine engines were developed for the EPA under contract with Carnegie Mellon University.[47] For the purposes of this analysis, emissions are included from all Category 2 engines operated in the Great Lakes, inland waterways, and coastal waters up to 320 kilometers (200 miles) offshore. Emissions from U.S. flagged vessels were determined using ship registry data, fuel consumption, rated power, operation assumptions, and fuel specific emission factors. Emissions from foreign flagged vessels were developed based on cargo movements and waterways data, vessel speeds, average dead weight tonnage per ship, and assumed cargo capacity factors.

To model the benefits of the proposed standards, EPA applied an engine replacement schedule and new engine standards to the baseline inventory. In this case, no emission reductions are expected beyond the already low levels of HC. Table 13 shows the projected emissions for Category 2 vessels with and without the proposed standards. The anticipated NOx impacts for the application of MARPOL Annex VI standards to U.S. flagged vessels are also included.

[47] Corbett, J., Fischbeck, P., "Commercial Marine Emissions Inventory and Analysis for United States Continental and Inland Waterways," Carnegie Mellon University, Order No. 8A-0516-NATX, September 1998.

Table 13
Category 2 Emissions Inventory (thousand short tons)

Year	HC	NOx			PM		CO	
	base	base	MARPOL Annex VI	control	base	control	base	control
2000	11.1	267	265	265	6.1	6.1	34.1	34.1
2010	12.3	295	275	255	6.8	6.6	37.7	36.3
2020	13.6	325	387	206	7.5	6.9	41.7	37.0
2030	15.0	360	309	167	8.3	7.3	46.0	38.3
2040	16.5	397	339	162	9.1	7.9	50.8	41.5

3. Category 3 Engines

The emissions inventory for Category 3 was calculated using the same methodology as for Category 2. EPA believes that some NOx benefits may be achieved by adopting the MARPOL Annex VI NOx standard for engines used in U.S. flagged vessels. Table 14 presents projected emissions from Category 3 engines operated in U.S. waters. Note that the reductions here present both the impacts, in the U.S., of U.S. flagged vessels meeting the MARPOL Annex VI NOx standard and the potential impacts if foreign flagged vessels were to meet the MARPOL Annex VI standard.

Table 14
Category 3 Baseline and Projected Emissions Inventory under
Varying Implementation of MARPOL Annex VI controls (thousand short tons)

Year	NOx			HC	PM	CO
	base	Annex VI applied to U.S.-flag vessels only	Annex VI applied to all vessels	base	base	base
2000	273	272	271	8.1	21.2	25.0
2010	301	290	279	9.0	23.4	27.6
2020	333	310	289	9.9	25.8	30.5
2030	368	338	309	10.9	28.6	33.7
2040	406	372	338	12.1	31.5	37.2

4. Total Impacts

Table 15 contains the baseline annual emissions from marine diesel engines as a whole as well as projections of the annual emissions with the MARPOL Annex VI requirements and proposed standards in place. According to this analysis, the proposed emission limits would result in reductions, beyond the MARPOL Annex VI limits, of 10 percent HC, 28 percent NOx, 12 percent PM, and 3 percent CO from marine diesel engines in 2020. Nationally, these reductions represents reductions of 1.3 percent NOx and 0.1 percent PM. Obviously, the percent reduction would be much higher for port areas. This is especially true for San Diego, Beaumont-Port Arthur, San Francisco and similar ports where marine diesel engines account for a large fraction of the NOx emissions.[48]

Table 15
Emission Inventory Impacts of the Proposed Rule

		2000	2010	2020	2030
HC 10^3 short tons	baseline	31.3	34.8	38.7	43.2
	controlled	31.3	33.3	35.4	39.3
	reduction	0%	4%	9%	9%
NOx 10^3 short tons	baseline	1,005	1,117	1,244	1,390
	IMO	1,001	1,072	1,162	1,287
	controlled	1,001	965	819	815
	reduction	0%	10%	28%	34%
PM 10^3 short tons	baseline	42.3	46.9	52.2	58.2
	controlled	42.3	44.1	45.7	50.2
	reduction	0%	6%	12%	14%
CO 10^3 short tons	baseline	133	147	165	184
	controlled	133	146	160	177
	reduction	0%	1%	3%	4%

In addition to the effect of the proposed standards on direct PM emissions noted above, the proposed standards are expected to reduce the concentrations of secondary PM. Secondary PM is formed when NOx reacts with ammonia in the atmosphere to yield ammonium nitrate particulate. As described in Chapter 5 of the Draft RIA, each 100 tons

[48] Marine diesel engines make up about approximately 17% of the NOx on a summer day for San Diego, 15 % for Beaumont-Port Arthur, and 12% for San Francisco. See, Commercial Marine Vessel Contributions to Emission Inventories, Final Report, Submitted by Booz-Allen & Hamilton, Inc., October 7, 1991.

of NOx reduction results in about a 4-ton reduction in secondary PM. This conversion rate varies from region to region, and is greatest in the West. EPA estimates that the 425,000 tons per year total NOx reduction projected for marine engines in 2020 would result in about an 17,000 tons per year reduction in secondary PM. This secondary PM reduction is more than double the direct PM reductions for 2020 projected for this proposed rule.

EPA also believes the proposed regulations will tend to reduce noise. One important source of noise in diesel combustion is the sound associated with the combustion event itself. When a premixed charge of fuel and air ignites, the very rapid combustion leads to a sharp increase in pressure, which is easily heard and recognized as the characteristic sound of a diesel engine. The conditions that lead to high noise levels also cause high levels of NOx formation. Fuel injection changes and other NOx control strategies therefore typically reduce engine noise, sometimes dramatically.

EPA does not anticipate any negative impacts on energy or safety as a result of this proposed rule. The impact of the proposed standards on energy is measured by the effect on fuel consumption from complying engines. Although it is not expected to be a primary compliance strategy, marine engine manufacturers could retard engine timing to comply with emission limits. This could lead to an increase in fuel consumption in the absence of other changes to the engines. Most of the technology changes anticipated in response to the proposed standards, however, have the potential to reduce fuel consumption as well as emissions. Therefore, on balance, no increase in energy consumption is expected. As far as safety is concerned, EPA believes that marine engine manufacturers will use only proven technology that is currently used in other engines such as nonroad land-based diesel applications, locomotives, and diesel trucks.

B. Economic impacts

EPA expects that in almost all cases, manufacturers will produce a complying marine engine by adapting an engine that has been designed and certified to meet highway or nonroad emission standards. This analysis considers the cost of these upgrades to the base engines as part of the impact of new marine emission standards; variable costs are applied directly, with an additional fixed cost added to apply the technologies to marine engines. The analysis arrives at the full cost impact by considering changes to turbocharging and aftercooling applicable to marine engines. Full details of EPA's cost analysis can be found in Chapter 4 of the Draft RIA.

1. Methodology

In assessing the economic impact of setting emission standards, EPA has made a best estimate of the combination of technologies that an engine manufacturer might use to meet the new standards at an acceptable cost. In some cases, however, it is difficult to make a distinction between technologies needed to reduce emissions for compliance with emission standards and those technologies that offer other benefits for improved fuel economy, power density, and other aspects of engine performance. EPA believes that without new emission standards, manufacturers would continue research on and eventually deploy many technological upgrades to improve engine performance or more cost-effectively control emissions. Modifications to fuel injection systems and the introduction of electronic controls are expected to continue, regardless of any change in emission standards, to improve engine performance. This is especially true for marine engines, which generally benefit from the transfer of highway and land-based engine technology improvements. Some further development with a focus on NOx, HC, and PM emissions will nevertheless play an important role in achieving emission reduction targets.

Because several technology upgrades have benefits that go beyond reducing emissions, a difficulty in assessing the impact of new emission standards is establishing the appropriate technology baseline from which to make projections. Ideally, the analysis would establish the mix of technologies that manufacturers would have introduced absent the changes in emission standards, then make a projection for any additional changes in hardware or calibration required to comply with those standards. This is especially important for marine engines, since technology improvements are often carried over from counterpart land-based engines. The costs of those projected technology and calibration changes would then most accurately quantify the impact of setting new emission standards. While it is difficult to take into account the effect of ongoing technology development, EPA is concerned that assessing the full cost of the anticipated technologies as an impact of the new emission standards would inappropriately exclude from consideration the observed benefits for engine performance, fuel consumption, and durability.[49] Short of having sufficient data to predict the future with a reasonable degree of confidence, EPA faces the need to devise an alternate approach to quantifying the true impact of the new emission standards. EPA requests comment on the most appropriate way of accounting for these non-emission benefits.

A variety of technological improvements are projected for complying with the new emission standards. Selecting these technology packages requires extensive engineering analysis and judgment. The fact that manufacturers will be applying extensive effort to improve diesel engine technologies across programs ensures that these technologies will develop significantly before reaching production. This ongoing research and development will lead to reduced costs in three ways. First, research will lead to enhanced effectiveness for individual technologies, allowing manufacturers to use simpler packages of emission control technologies than would otherwise be predicted given the current state of development. Similarly, the continuing effort to improve the emission control technologies will include innovations that allow lower-cost production. Finally, manufacturers will focus research efforts on any potential drawbacks, such as increased fuel consumption or maintenance costs, attempting to minimize or overcome any negative effects.

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[49]While EPA does not anticipate widespread, marked improvements in fuel consumption, small improvements on some engines may occur.

Estimated cost increases are presented as incremental changes in purchase price. The incremental change in purchase price for new engines and equipment is comprised of variable costs (for hardware and assembly time) and fixed costs (for research and development, retooling, and certification). Total operating costs, including maintenance and fuel consumption, are considered as well. Cost estimates based on these projected technology packages represent an expected incremental cost of engines as they begin to comply with new emission standards. Costs in subsequent years are projected to decrease due to several factors, as described below. Separate projected costs were derived for engines used in five different ranges of rated power; costs were developed for engines near the middle of the listed ranges. All costs are presented in 1998 dollars.

While the following analysis projects a relatively uniform emission control strategy for designing the different categories of engines, this should not suggest that EPA expects a single combination of technologies will be used by all manufacturers. In fact, depending on basic engine emission characteristics, EPA expects that control technology packages will gradually be fine-tuned to different applications. Furthermore, EPA expects manufacturers to use averaging, banking, and trading programs as a means to deploy varying degrees of emission control technologies on different engines. EPA nevertheless believes that the projections presented here provide a cost estimate representative of the different approaches manufacturers may ultimately take.

2. Engine Technologies

The land-based engines that serve as the base engines for marine diesel applications will be changing as a result of new emission standards adopted for nonroad and locomotive engines. Most new land-based nonroad and locomotive engines rated over 37 kW will be subject to two new tiers of standards spanning the next ten years. These engines will be designed, manufactured, and certified to have reduced emissions. The technological challenge for developing compliant marine engines is therefore to make the necessary engine modifications for marine applications without substantially increasing emission levels, while ensuring that these emission levels are maintained over the range of potential marine operation.

Manufacturers of Category 1 engines are expected to comply with the proposed Tier 2 emission limits by conducting basic engine modifications, upgrading fuel systems, adding some degree of electronic controls, or improving aftercooling systems. Manufacturers of Category 2 engines are expected to redesign combustion chambers, improve high-pressure electronic fuel injection systems, and upgrade or add turbocharging and aftercooling. For Tier 3 emission limits, all manufacturers are expected to rely on some form of electronically controlled common rail fuel system with separate-circuit aftercooling and exhaust gas recirculation.

Except for the aftercooling changes, hardware improvements for nonroad and locomotive engines should be transferrable to marine engines, in many cases with some degree of adaptation. The analysis includes a substantial amount of development time to make adjustments for turbocharger matching, reprogramming electronic control software, optimizing for emission performance over the not-to-exceed zone, and other changes that may be needed to prepare an engine for marine applications. Also, because manufacturers will in many cases be producing a new engine design outside of the normal product development cycle, extensive development costs are included to design a marine version of a base engine, taking into account not only direct expenses for controlling emissions, but also considering some need for re-optimizing performance. Finally, since marine engines rely on seawater, not the ambient air, for rejecting heat from the engine and aftercooler, the cost of adding these systems are considered separately.

3. Estimated Costs

The projected costs of these new technologies for meeting the new emission limits are itemized in the Draft RIA and summarized in Table 16. Anticipated incremental cost impacts of the Tier 2 emission limits for the first years of production range from $2,600 to $54,000 per engine, in general with proportionally higher projected costs for larger engines. Estimated costs for Tier 3 emission limits, which are calculated incremental to the Tier 2 projections, are similar, with first-year costs ranging from $5,300 to $45,000. Long-term impacts on engine costs are expected to be much lower, dropping to levels between $1,100 and $11,000 for Tier 3 engines. Most of this cost reduction is accounted for by the fact that development time and other fixed costs dominate the cost analysis, but disappear after the projected five-year amortization period.

The cost analysis also includes an estimated burden resulting from the need to do additional maintenance work during periodic rebuilds. Complying engines will be equipped with technologies that will require replacement of hardware that is either more expensive than from earlier models, or that is only used because of emission standards. Using typical rebuild schedules, the analysis projects incremental costs for multiple rebuilds, resulting in net-present-value costs that range from $700 to $12,000. In addition to rebuild cost impacts, Table 16 includes an estimated cost burden for conducting production line testing of 1 percent of total industry-wide production.

Ship and boat builders are not expected to face any increase in costs as a result of the new emission standards. Commercial vessels are built to accommodate a wide range of engines. Customers are therefore able to order a vessel by choosing from a broad selection of engine models. Because there is a degree of customizing in the construction of commercial vessels, EPA does not expect that future production will be sensitive to the anticipated changes in engine design resulting from the new emission standards. EPA requests comment on the extent to which commercial vessel construction may be affected by new emission standards.

Table 16
Projected Incremental Costs by Power Rating (kW)

Power Rating (kW)	Tier	Incremental Engine Cost*	Incremental Operating Cost per Engine (npv)
37-225	Tier 2	$2,577	$737
	Tier 3 (years 1-5)	$5,303	$829
	Tier 3 (year 6 and later)	$1,112	$829
225-560	Tier 2	$4,249	$1,128
	Tier 3 (years 1-5)	$6,210	$1,119
	Tier 3 (year 6 and later)	$1,829	$1,119
560-1000	Tier 2	$25,319	$207
	Tier 3 (years 1-5)	$25,507	$2,647
	Tier 3 (year 6 and later)	$5,601	$2,647
1000-2000	Tier 2	$22,725	$635
	Tier 3 (years 1-5)	$26,537	$4,519
	Tier 3 (year 6 and later)	$10,659	$4,519
2000-5000	Tier 2	$54,103	$12,430
	Tier 3 (years 1-5)	$44,583	$2,874
	Tier 3 (year 6 and later)	$3,169	$2,874

*Tier 3 costs are calculated incremental to Tier 2 estimates.

Characterizing these estimated costs in the context of their fraction of the total purchase price and life-cycle operating costs is helpful in gauging the economic impact of the new standards. Although the incremental cost projections in Table 16 increase dramatically with increasing power rating, they in fact represent a comparable price change relative to the total price of the engine. The estimated first-year cost increases are all at most 3 percent of estimated vessel prices, with even lower long-term effects, as described above.

Since vessel owners also decide between replacing and rebuilding existing engines, the cost impact relative to engine price is also relevant. EPA estimates that Tier 3 cost impacts will approach 10 or 15 percent of total engine prices. Once fixed costs are amortized, the cost impact drops to a range between 1 and 5 percent of total engine prices. EPA requests comment on the likelihood that these costs will affect normal rates of turnover to new engines.

4. Aggregate Costs to Society

The above analysis presents unit cost estimates for each power category. These costs represent the total set of costs borne by engine manufacturers to comply with emission standards. With current data for engine and vessel sales for each category and projections for the future, these costs can be translated into projected direct costs to the nation for the new emission standards in any year. Aggregate costs are estimated at about $19 million in the first year the new standards apply, increasing to a peak of about $57 million in 2008 as increasing numbers of engines become subject to the new standards. The following years show a drop in aggregate costs as the per-unit cost of compliance decreases, resulting in aggregate costs of about $14 million in 2015, followed by slowly growing costs due to increasing sales over time.

5. Sensitivity Analysis

There has been some concern expressed that the technologies used to meet emission requirements for land-based engines will be less effective at controlling emissions from marine engines. Some of the reasons suggested for needing a more aggressive approach include the change in duty cycle, the effects of "marinizing" an engine, and the need to comply with emission limits across not-to-exceed zones. Manufacturers could rely on injection timing retard as a technology option for achieving an additional measure of NOx control. Also, manufacturers may choose, for example, to avoid the high R&D costs of implementing a new technology for an engine family with low sales volume by relying on timing retard as a lower-cost alternative. In addition, manufacturers using EGR may need to add exhaust gases during medium- and high-load operation to the point that there would be an increase in fuel consumption that cannot be offset by improvements such as better control of fuel injection. EPA therefore conducted a sensitivity analysis to show the costs associated with a fuel penalty resulting from relying on retarded timing or EGR.

Because the requirement to control emissions throughout an engine’s operating range poses the greatest challenge at low speeds and loads, EPA calculated the costs of increasing fuel consumption by one percent at modes 2 and 3 and by three percent at mode 4 (lightest load operation). Using the weightings for the composite duty cycle, increased life-cycle fuel consumption from this net 1.0 percent fuel penalty can be calculated and then discounted to the present at a 7 percent rate. The resulting estimated net-present-value cost increase ranges from $400 for a 100 kW engine to $19,000 for a 3000 kW engine. Considering the established effectiveness of timing retard as a strategy to control NOx emissions, this may be considered a viable approach, either as a substitute or a supplemental technology.

C. Cost-effectiveness

EPA has estimated the cost-effectiveness (i.e., the cost per ton of emission reduction) of the proposed marine standards for the same nominal power ratings of marine engines and vessels highlighted earlier in this section. This analysis has been performed only for Category 1 and Category 2 marine engines, since the proposed regulation would not apply to Category 3 engines. Chapter 6 of the Draft RIA contains a more detailed discussion of the cost-effectiveness analysis.

As described in the Draft RIA, neither costs nor emission benefits were attributed to the not-to-exceed provisions included in this proposal. The calculated cost-effectiveness of the proposed emission limits presented here therefore includes all the anticipated effects on costs and emission reductions.

1. Tier 2

For determining the cost-effectiveness of the Tier 2 portion of this proposal, only benefits beyond those achieved by the MARPOL Annex VI standard are considered. EPA believes this is a conservative estimate because EPA attributed all of the costs of the technology associated with the Tier 2 levels to this action and did not attribute any of these costs to the MARPOL Annex VI standard. For the sake of this analysis, EPA assumed that all of the increased costs were incurred to achieve HC+NOx benefits. NOx reductions represent approximately 98 percent of the total HC+NOx emission reductions expected from the proposed standards. Table 17 presents the cost-effectiveness of the Tier 2 standards.

Table 17
Cost-Effectiveness of the
Proposed Marine Tier 2 Standards for HC and NOx

Nominal Power (kW)	NPV of Total Lifetime Costs	NPV Benefits (short tons)	Discounted Cost-Effectiveness	Cost-Effectiveness without Non-emission Benefits
100	$1,938	4.3	$449	$738
400	$3,016	26	$116	$201
750	$22,713	80	$283	$317
1500	$20,386	267	$76	$86
3000	$47,754	829	$58	$76

Weighting the projected cost and emission benefit numbers presented above by the populations of the individual power categories, EPA calculated the cost-effectiveness of the proposed HC+NOx standards for Category 1 and 2 both separately and combined. Table 18 contains the resulting aggregate cost-effectiveness results for the proposed Tier 2 standards.

Table 18
Aggregate Cost-Effectiveness for the
Proposed Marine Tier 2 Standards for HC and NOx

	NPV of Total Lifetime Costs	NPV Benefits (short tons)	Discounted Cost-Effectiveness
Category 1	$3,669	24	$156
Category 2	$47,754	829	$58
Combined	$4,617	41	$113

While the cost estimates described under the Economic Impacts do not take into account the observed value of performance improvements in the field, these non-emission benefits should be taken into account in the calculation of cost-effectiveness. EPA believes that an equal weighting of emission and non-emission benefits is justified for those technologies which clearly have substantial non-emission benefits, namely electronic controls, fuel injection changes, turbocharging, and engine modifications. For some or all of these technologies, a greater value for the non-emission benefits could likely be justified. This has the effect of halving the cost for those technologies in the cost-effectiveness calculation. The cost-effectiveness values in this document are based on this calculation methodology. Cost-effectiveness values are shown without adjustment for non-emission benefits in Tables 17 and 19 for comparison purposes. EPA requests comment on this approach.

2. Tier 3

As described above in the preceding section, the projected costs of complying with the proposed standards will vary by the rated power and model year (i.e., year 1 versus year 6). Therefore, the cost-effectiveness will also vary from model year to model year. For comparison purposes, the discounted costs, emission reductions, and cost-effectiveness of the marine Tier 3 HC+NOx standards are shown in Table 19 for the same model years discussed in the preceding section. The cost-effectiveness of the proposed Tier 3 standards has been calculated incrementally to the costs and benefits associated with the proposed Tier 2 standards. This analysis was performed similarly to the Tier 2 analysis. According to this analysis, the cost-effectiveness of the proposed Tier 3 program is roughly equivalent to that of the proposed Tier 2 program. Table 19 presents the cost-effectiveness results for the five nominal power ratings.

Table 19
Cost-Effectiveness of the
Proposed Marine Tier 3 Standards for HC and NOx

Nominal Power (kW)	Model Year Grouping	NPV of Total Lifetime Costs	NPV Benefits (short tons)	Discounted Cost-Effectiveness	Cost-Effectiveness without Non-emission Benefits
100	1 to 5	$4,831	4.2	$1,155	$1,407
	6 +	$1,166		$279	$451
400	1 to 5	$5,804	30	$196	$236
	6 +	$1,726		$58	$99
k 750	1 to 5	$23,834	77	$308	$351
	6 +	$4,831		$62	$103
1500	1 to 5	$24,279	136	$178	$216
	6 +	$8,402		$62	$112
3000	1 to 5	$36,652	290	$127	$163
	6 +	$4,553		$16	$20

As with Tier 2, EPA calculated the cost-effectiveness of the proposed Tier 3 HC+NOx standards for Category 1 and 2 both separately and combined by weighting the projected cost and emission benefits by the populations of the individual power categories. Table 20 contains the resulting aggregate cost-effectiveness results for the proposed Tier 3 standards.

Table 20
Aggregate Cost-Effectiveness for the
Proposed Marine Tier 3 Standards for HC and NOx

	Model Year Grouping	NPV of Total Lifetime Costs	NPV Benefits (short tons)	Discounted Cost-Effectiveness
Category 1	1 to 5	$6,503	20	$327
	6 +	$1,709		$87
Category 2	1 to 5	$36,652	290	$127
	6 +	$4,553		$16

Combined	1 to 5	$7,151	26	$278
	6 +	$1,799		$70

3. Comparison to Other Programs

In an effort to evaluate the cost-effectiveness of the HC+NOx controls for marine engines, EPA has summarized the cost-effectiveness results for five other recent EPA mobile source rulemakings that required reductions in NOx (or NMHC+NOx) emissions. The heavy-duty vehicle portion of the Clean Fuel Fleet Vehicle Program yielded a cost-effectiveness of approximately $1,500 per ton of NOx. The most recent NMHC+NOx standards for highway heavy-duty diesel engines yielded a cost-effectiveness of $100-$600 per ton of NMHC+NOx. The newly adopted standards for locomotive engines yielded a cost-effectiveness of $160-$250 per ton of NOx. Finally, the recent standards for nonroad engines reported a cost-effectiveness of $410-$600 per ton. The cost-effectiveness of the new HC+NOx standards for marine diesel engines presented above is more favorable than the cost-effectiveness than any of the other recent programs.

EPA has also summarized the cost-effectiveness results for three other recent EPA mobile source rulemakings that required reductions in PM emissions. The cost-effectiveness of the most recent urban bus engine PM standard was estimated to be $10,000-$16,000 per ton, and the cost-effectiveness of the urban bus retrofit/rebuild program was estimated to be approximately $25,000 per ton. The nonroad FRM reported a cost-effectiveness for PM, using the same conservative method used here for marine, of $2,300 per ton. The PM cost-effectiveness of the new emission standards presented above is more favorable than that of either of the urban bus programs and is comparable to the nonroad rule.

For comparison to other PM control strategies, EPA has also analyzed the PM cost-effectiveness of the new standards if any of the costs were attributed to PM. EPA conservatively made these calculations as if half of the increased costs were attributable to PM control. This approach effectively double-counts these costs, since the full cost of the program is assessed in the calculation of cost-effectiveness for NOx+HC. This aggregate discounted lifetime cost-effectiveness represents the highest figure that could be expected for cost-effectiveness of the new standards and was calculated to provide an indication of the upper bound of PM cost-effectiveness values. The resulting fleet-wide discounted lifetime cost-effectiveness of the proposed PM standards is approximately $600-$2,600 per ton. This cost-effectiveness is much better than for the urban bus PM standard and the urban bus retrofit/rebuild program and is comparable to the nonroad Tier 2 standards.

In addition to the benefits of reducing ozone within and transported into urban ozone nonattainment areas, the NOx reductions from the new standards are expected to have beneficial impacts with respect to crop damage, secondary particulate formation, acid deposition, eutrophication, visibility, and forests, as described earlier. Because of the difficulty of quantifying the monetary value of these societal benefits, the cost-effectiveness values presented do not assign any numerical value to these additional benefits. However, based on an analysis of existing studies that have estimated the value of such benefits in the past, the Agency believes that the actual monetary value of the multiple environmental and public health benefits produced by large NOx reductions similar to those projected under this final rule will likely be greater than the estimated compliance costs.

IX. Public Participation

A. Comments and the Public Docket

Publication of this document opens a formal comment period for this proposal. EPA will accept comments for the period indicated under "DATES" above. The Agency encourages all parties that have an interest in the program described in this document to offer comment on all aspects of this rulemaking. Throughout this proposal are requests for specific comment on various topics.

EPA attempted to incorporate all the comments received in response to the ANPRM, though not all comments are addressed directly in this document. Anyone who has submitted comments on the ANPRM, or any of EPA's previous publications related to marine diesel engines, and feels that those comments have not been adequately addressed is encouraged to resubmit comments as appropriate.

The most useful comments are those supported by appropriate and detailed rationales, data, and analyses. The Agency also encourages commenters that disagree with the proposed program to suggest and analyze alternate approaches to meeting the air quality goals of this proposed program. All comments, with the exception of proprietary information, should be directed to the EPA Air Docket Section, Docket No. A-97-50 before the date specified above.

Commenters wishing to submit proprietary information for consideration should clearly separate such information from other comments by (1) labeling proprietary information "Confidential Business Information" and (2) sending proprietary information directly to the contact person listed (see "FOR FURTHER INFORMATION CONTACT") and not to the public docket. This will help ensure that proprietary information is not inadvertently placed in the docket. If a commenter wants EPA to use a submission of confidential information as part of the basis for the final rule, then a nonconfidential version of the document that summarizes the key data or information should be sent to the docket.

Information covered by a claim of confidentiality will be disclosed by EPA only to the extent allowed and in accordance with the procedures set forth in 40 CFR part 2. If no claim of confidentiality accompanies the submission when it is received by EPA, it will be made available to the public without further notice to the commenter.

B. Public Hearing

The Agency will hold a public hearing as noted under "DATES" above. Any person desiring to present testimony at the public hearing is asked to notify the contact person listed above at least five business days prior to the date of the hearing. This notification should include an estimate of the time required for the presentation of the testimony and any need for audio/visual equipment. EPA suggests that sufficient copies of the statement or material to be presented be available to the audience. In addition, it is helpful if the contact person receives a copy of the testimony or material prior to the hearing.

The hearing will be conducted informally, and technical rules of evidence will not apply. A sign-up sheet will be available at the hearing for scheduling the order of testimony. A written transcript of the hearing will be prepared. The official record of the hearing will be kept open for 30 days after the hearing to allow submittal of supplementary information.

X. Administrative requirements

A. Administrative Designation and Regulatory Analysis

Under Executive Order 12866, the Agency must determine whether this regulatory action is "significant" and therefore subject to Office of Management and Budget (OMB) review and the requirements of the Executive Order (58 FR 51735, Oct. 4, 1993). The order defines "significant regulatory action" as any regulatory action that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or,

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Pursuant to the terms of Executive Order 12866, EPA has determined that this proposal is a "significant regulatory action." If implemented as proposed, EPA's estimates show total societal costs for most years between $15 million and $20 million, with peak costs reaching about $57 million in 2008. This action was submitted to the Office of Management and Budget for review and a Draft RIA has been prepared and is available in the docket associated with this rulemaking. Any written comments from OMB and any EPA response to OMB comments are in the public docket for this proposal.

B. Regulatory Flexibility

The Regulatory Flexibility Act (RFA) generally requires an agency to conduct a regulatory flexibility analysis of any rule subject to notice and comment requirements, unless the Agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small not-for-profit enterprises, and small governmental jurisdictions. For the reasons set out below, this proposed rule would not have a significant impact on a substantial number of small entities.

EPA has identified five types of entities that may be affected by the proposed rule: engine manufacturers, engine dressers, post-manufacture marinizers, commercial vessel builders, and commercial boat builders. A sixth group of entities, recreational vessel builders, is not considered in this analysis because, as described in Section III.B.1, above, EPA is proposing to exempt these engines from the proposed emission control program.

Using the Small Business Administration definition of small for this industry sector (fewer than 500 employees), one group of entities, marine engine manufacturers, presents no small business impacts concerns because all of the manufacturers are large.

There are numerous entities with fewer than 500 employees that manufacture commercial vessels and commercial boats.[50] However, the proposed emission control program is expected to impose very little additional cost on these entities. This is because, according to discussions with several of these vessel and boat builders as well as with one of their trade associations, the production of commercial vessels is flexible enough to accommodate physical changes to the engine without vessel redesign.

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[50]Commercial vessels are larger merchant vessels, typically exceeding 400 feet in length and generally used in waterborne trade and/or passenger transport. Commercial boats are smaller service, industrial, and fishing vessels generally used in inland and coastal waters. A more in-depth description of these industry sectors is contained in "Industry Characterization: Commercial Marine Vessel Manufacturers" prepared by ICF Incorporated for US Environmental Protection Agency, Contract No. 68-C5-0010, Work Assignment 211, September 1998 (Docket No. A-97-50).

As described in Section III.C.2 above, engine dressers are companies that adapt a land-based diesel engine for use in the marine environment by adding mounting hardware, a marine cooling system, a generator, or propeller gears, but without changing the engine in ways that may affect emissions (see Section III.B.2, above). These companies are typically small, regional companies, with few employees and relatively small annual sales in terms of both dollars and units. Because these companies are proposed to be exempt from the certification and compliance programs set out in today's action, EPA believes that they will incur very minor costs as a result of the proposed program. Their only compliance burden consists of an annual report that must be submitted to EPA to demonstrate that they meet the criteria for the engine dresser exemption described in Section III.B.2. This reporting requirement is expected to impose very little additional cost on these companies.

The group of small entities likely to be affected by the proposed rule are post-manufacture marinizers (PMM). Unlike engine dressers, PMM modify a land-based engine for use in the marine environment by changing it in ways that may affect emissions. This includes, but is not limited to, changes to the fuel or cooling systems. The following discussion of the impacts on small post-manufacture marinizers is derived from an impact assessment prepared for this rulemaking by ICF Incorporated and discussions with small PMM.[51]

Through conversations with engine manufacturers and vessel builders, EPA initially identified twelve small post-manufacture marinizers. Four of these were subsequently eliminated from the Agency's PMM impact analysis (two were eliminated because there were subsidiary companies of other companies on the list; two others were eliminated because they do not produce Category 1 marine engines). The eight remaining companies were used to develop a model small company, for purposes of exploring the impact of this rulemaking. Using this model small company as a guide, it was estimated that average compliance costs would range from 1.3 percent to 3.9 percent, depending on the compliance cost scenario used.[52] EPA thus concludes that, provided the compliance burdens of these companies can be reduced, an impact of approximately 1.3 percent can be anticipated. As discussed above, this proposal contains many flexibility provisions for small post-manufacture marinizers, including an expanded definition of engine family, which is expected to reduce the number of certification tests these companies will be required to do; a streamlined certification process, beginning the year after the implementation of the emissions limits provided the emissions of their highest emitting engine has not changed; an extra year for compliance; and special hardship provisions.

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[51]Characterization and Small Business Impact Assessment for Small and Large Marine Compression Ignition Engine Manufacturers/Marinizers, prepared by ICF Incorporated for U.S. Environmental Protection Agency, Contract Number 68-C5-0010, Work Assignment Number 211, September 1998 (Air Docket A-97-50).

[52]Three cost scenarios were explored: $100,000, $200,000, and $300,000 per engine family.

Because the number of companies examined is so small, EPA also performed an analysis using company-specific data instead of the model company. According to this data, in the least costly compliance scenario, four small PMM may be affected by more than 3 percent of sales, 2 companies by 1-3 percent of sales, and 2 companies less than 1 percent of sales,. Of the four companies originally projected to be affected by more than 3 percent of sales, two were eliminated because they are, in fact, engine dressers; hence, the original estimate of 3 percent is an overstatement of costs for these companies. As discussed above, engine dressers would only be subject to a reporting requirement, which is expected to impose very little additional cost. Consequently, it is expected that two small companies may be affected by more than 3 percent of annual sales. However, it may be possible for these companies to reduce the impacts of this rule further. For example, these companies could marinize a cleaner engine, thus reducing the design and development costs associated with bringing a previous tier engine to the proposed emission limits. Alternatively, they may be able to work more closely with the base engine manufacturer to reduce the need for extensive redesign of their marinization process.

Subsequent to completion of the ICF impact assessment, EPA identified several other small PMM (see the Draft Regulatory Assessment for a complete list of small PMM). However, analysis of their financial data does not change the above conclusion that most small PMM could avoid high compliance costs by applying the proposed small PMM flexibility provisions. Therefore, EPA believes it is appropriate to certify this rulemaking as not having a significant economic impact on a substantial number of small companies.

Therefore, I certify that this action will not have a significant economic impact on a substantial number of small entities.

The Agency continues to be interested in the potential impacts of the proposed rule on small entities and welcomes additional comments during the rulemaking process on issues related to such impacts. The Agency is continuing its efforts to notify other small business engine and equipment manufacturers of this rule and inform them of their opportunities for providing feedback to the Agency.

C. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (OMB) under the *Paperwork Reduction Act*, 44 U.S.C. 3501 *et seq.* An Information Collection Request has been prepared by EPA, and a copy may be obtained from Sandy Farmer, OPPE Regulatory Information Division; U.S. Environmental Protection Agency (2137); 401 M St., S.W.; Washington, DC 20460 or by calling (202) 260-2740.

The information being collected is to be used by EPA to ensure that new marine diesel engines comply with applicable emissions standards through certification requirements and various subsequent compliance provisions.

The annual public reporting and recordkeeping burden for this collection of information is estimated to average 589 hours per response, with collection required annually. The estimated number of respondents is 32. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, disclose, or provide information to or for a federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjusting the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are displayed in 40 CFR Part 9 and 48 CFR Chapter 15.

Comments are requested on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques. Send comments on the ICR to the Director, OPPE Regulatory Information Division; U.S. Environmental Protection Agency (2137); 401 M St., S.W.; Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th St., N.W., Washington, DC 20503, marked "Attention: Desk Officer for EPA." Include the ICR number in any correspondence. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after **[Insert date of publication in the FEDERAL REGISTER]**, a comment to OMB is best ensured of having its full effect if OMB receives it by **[Insert date 30 days after publication in the FEDERAL REGISTER]**. The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

D. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 104-4, establishes requirements for federal agencies to assess the effects of their regulatory actions on state, local, and tribal governments and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "federal mandates" that may result in expenditures to state, local, and tribal governments, in the aggregate, or to the private sector, of $100 million or more in any one year. Before promulgating an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if the Administrator publishes with the final rule an explanation of why that alternative was not adopted. Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

EPA has determined that this rule does not contain a Federal mandate that may result in expenditures of $100 million or more for State, local, and tribal governments, in the aggregate, or the private sector in any one year. The rule does not impose any enforceable duties on State, local, or tribal governments, i.e., they manufacture no engines and are therefore not required to comply with the requirements of this rule. For the same reason, EPA has determined that this rule also contains no regulatory requirements that might significantly or uniquely affect small governments. EPA projects that annual economic effects will be far less than $100 million. Thus, this proposed rule is not subject to the requirements of sections 202 and 205 of the UMRA.

E. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law 104-113, § 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless doing so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rule involves technical standards. As described in Section V.E. above, ISO standards are a potentially applicable voluntary consensus standard. The Agency has decided, however, not to propose ISO procedures in this rulemaking. The Agency has determined that these procedures would be impractical because they rely too heavily on reference testing conditions. Because the test procedures in these regulations need to represent in-use operation typical of operation in the field, they must be based on a range of ambient conditions. EPA has determined that the ISO procedures are not broadly usable in their current form, and therefore cannot be adopted by reference. EPA has instead chosen to rely on the procedures outlined in 40 CFR Part 89, Subparts D and E. EPA is hopeful that future ISO test procedures will be developed that are usable for the broad range of testing needed, and that such procedures could then be adopted by reference. EPA also expects that any development of revised test procedures will be done in accordance with ISO procedures and in a balanced manner and thus include the opportunity for involvement of a range of interested parties (potentially including parties such as industry, EPA, state governments, and environmental groups) so that the resulting procedures can represent these different interests.

F. Protection of Children

Executive Order 13045, entitled "Protection of Children from Environmental Health Risks and Safety Risks" (62 FR 19885, April 23, 1997), applies to a rule that is determined to be "economically significant," as defined under Executive Order 12866, if the environmental health or safety risk addressed by the rule has a disproportionate effect on children. For these rules, the Agency must evaluate the environmental health or safety effects of the planned rule on children; and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposed rule is not subject to Executive Order 13045, because it does not involve decisions on environmental health or safety risks that may disproportionately affect children. Moreover, this rule is determined not to be economically significant under Executive Order 12866.

G. Enhancing the Intergovernmental Partnership under Executive Order 12875

Under Executive Order 12875, EPA may not issue a regulation that is not required by statute and that creates a mandate upon a State, local or tribal government, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by those governments, or EPA consults with those governments. If EPA complies by consulting, Executive Order 12875 requires EPA to provide to the Office of Management and Budget a description of the extent of EPA's prior consultation with representatives of affected State, local and tribal governments, the nature of their concerns, copies of any written communications from the governments, and a statement supporting the need to issue the regulation. In addition, Executive Order 12875 requires EPA to develop an effective process permitting elected officials and other representatives of State, local and tribal governments "to provide meaningful and timely input in the development of regulatory proposals containing significant unfunded mandates."

This rule would not create a mandate on State, local or tribal governments. The rule would not impose any enforceable duties on these entities, because they do not manufacture any engines that are subject to this rule. This rule would be implemented at the federal level and impose compliance obligations only on private industry. Accordingly, the requirements of section 1(a) of Executive Order 12875 do not apply to this rule.

H. Consultation and Coordination with Indian Tribal Governments

Under Executive Order 13084, EPA may not issue a regulation that is not required by statute, that significantly or uniquely affects the communities of Indian tribal governments, and that imposes substantial direct compliance costs on those communities, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by the tribal governments, or EPA consults with those governments. If EPA complies by consulting, Executive Order 13084 requires EPA to provide to the Office of Management and Budget, in a separately identified section of the preamble to the rule, a description of the extent of EPA's prior consultation with representatives of affected tribal governments, a summary of the nature of their concerns, and a statement supporting the need to issue the regulation. In addition, Executive Order 13084 requires EPA to develop an effective process permitting elected officials and other representatives of Indian tribal governments "to provide meaningful and timely input in the development of regulatory policies on matters that significantly or uniquely affect their communities."

This rule would not significantly or uniquely affect the communities of Indian tribal governments. As noted above, this rule would be implemented at the federal level and impose compliance obligations only on private industry. Accordingly, the requirements of section 3(b) of Executive Order 13084 do not apply to this rule.

XI. Statutory Authority

In accordance with section 213(a) of the Clean Air Act, 42 U.S.C. 7547(a), EPA conducted a study of emissions from nonroad engines, vehicles, and equipment in 1991. Based on the results of that study, EPA determined that emissions of NOx, VOCs (including HC), and CO from nonroad engines and equipment contribute significantly to ozone and CO concentrations in more than one nonattainment area (see 59 FR 31306, June 17, 1994). Given this determination, section 213(a)(3) of the Act requires EPA to promulgate (and from time to time revise) emissions standards for those classes or categories of new nonroad engines, vehicles, and equipment that in EPA's judgment cause or contribute to such air pollution. EPA has determined that marine diesel engines rated over 37 kW "cause or contribute" to such air pollution. (See the June 1994 final rule and Section II.A. above).

Where EPA determines that other emissions from new nonroad engines, vehicles, or equipment significantly contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, section 213(a)(4) authorizes EPA to establish (and from time to time revise) emission standards from those classes or categories of new nonroad engines, vehicles, and equipment that EPA determines cause or contribute to such air pollution. In the June 1994 final rule, EPA made this determination for emissions of PM and smoke from nonroad engines in general and for diesel nonroad engines rated over 37 kW. With this document, EPA is making the same findings for marine diesel engines. (See Section II.A. above).

List of Subjects in 40 CFR Part 94
Environmental protection, Administrative practice and procedure, Confidential business information, Diesel fuel, Imports, Incorporation by reference, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Warranties.

Dated: November 24, 1998.

Carol M. Browner,
Administrator.